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ABSTRACT

A major goal of the elementary and secondary schools is to help each person become an efficient and autonomous learner. Outlined in this report are skills abstracted from the literature on such topics as verbal learning, problem solving, study habits, and behavior modification. The learner-oriented skills are presented so that they may be operationalized, taught, and evaluated. The report conceptualizes learning activities for potential management by the learner himself. Self-management of learning activities is necessary for success in higher education and all but the most routine occupations. The authors work toward the understanding and improvement of the processes of learning in the upper grades, which have been less adequately dealt with than the first three or four years of instruction. Sample objectives and items are included, with a list of selected instructional materials for learning skills. (Author/NMF)

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LEARNING SKILLS

REVIEW AND DOMAIN CHART

N. CECIL CLARK

AND

FAITH E. THOMPSON

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LEARNING SKILLS:

Review and Domain Chart

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June, 1972

Evaluation Training Center
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INTRODUCTION

Conceptualizing an area called Learning Skills began with the review of a large body of literature on such topics as verbal learning, problem solving, study habits, and behavior modification. Abstracted from these writings were skills supported by varying amounts of empirical evidence. If one placed skills on a continuum from micro to macro, those falling nearer the central portion comprise the domain of current interest. Eliminated were such extremes as "discriminating letters from numerals" and "writing a term paper." Skills were re-stated from the forms of learning principles or teaching methods to learner-controlled activities. To be included, a skill must have offered some potential for leading to objectives and assessment itesm. No statements on the order of "improving attitude toward learning" or "Enhancing self concept as a learner" appear in the domain outline. These are not skills, but can be dependent variables to be measured by appropriate instruments.

The skills outlined in this report appear most appropriate for learners beyond the primary level of schooling. The first three or four years of instruction have been more adequately dealt with than the upper grades. Language Arts specialists have expended great efforts to understanding and improving the processes involved in the learning and teaching of reading. In addition, a review of 71 sets of instructional materials for higher-order cognitive skills revealed a heavier concentration on the earlier grades, leaving a need for more material for the older learners.

A major goal of the elementary and secondary schools is for each person to become an efficient and autonomous learner. This self-management of the learning activities is needed for success in higher education and in all but the most routine occupations. The proportion of learning activities that can potentially be managed by the learner himself increases from near zero in kindergarten to near one hundered per cent at advanced levels. A profitable time to begin formal training is at about the fourth grade, after basic reading has been mastered by most students. Even a non-reader might benefit from training in memory techniques or productive thinking.

Further development of Learning Skills and Assessment appears warranted by (1) the continuing knowledge explosion, (2) the increasing commitment to individualized instruction, (3) the need for preparing youth for future change, (4) the success of the present brief project in collecting a large number of potential skills, and (5) the high probability that a significant number of the skills can be operationalized, taught, and evaluated. There will be a need later for systematic research to determine the validity of each skill that survives to become part of an instructional program.

The present project is seen as a step in making the products of learning scholarship and laboratory experiments more useful to the everyday learner. The process of translating what is known about learning from the perspective of an experimenter or teacher to a learner orientation appears to offer some promise. Skills can be added, deleted, or revised over a period of time. A sufficient number should emerge to make the effort worthwhile.

1. SELF MANAGING

Performance based learning is the core of the present educational trend. Each subject area is reconstructing its presentation of subject matter in terms of specific objectives which can be measured. If a learner is to take responsibility for part or all of his own learning, it is essential that he become aware of his own activities in terms of setting performance goals. He needs some strategy for analyzing tasks he is assigned or chooses. He needs to feel the achievement when intermediate goals are met. He needs some criteria for selecting goals to insure proper specificity and difficulty.

Two formal approaches to task analysis are described in the literature: an information processing approach and a heirarchical approach (Merrill, 1970; Gagne, 1970).

An information process analysis is appropriate when the output of one task, subskill, or operation is required as an input for a succeeding operation. The analysis at the first level is to determine the subskills and discover ordered relationships. At the second level, a determination must be made of the most efficient instructional paradigm for teaching or learning a particular subskill, rule or operation. Task subskills may be related according to complexity, chronology, spatiality, or interdependence. The information processing procedure may be an algorithmic procedure--a set of operations guaranteed to produce terminal behavior--or it may be a heuristic procedure: rules which lead to a solution, but do not guarantee attainment of terminal behavior (Merrill, 1970).

Analyzing a task according to a hierarchical approach is appropriate where lower ordered skills generate positive transfer to higher level

skills. The analysis should start with the terminal behavior and identify subordinate skills. The appropriate question would be: what would the learner have to know how to do in order to learn a new skill simply by being given verbal instruction (Gagne, 1962)?

Both Gagne's and Merrill's approaches reveal a structure of skills or operations having an ordered relationship. The nature of the ordered relationship is different. In a hierarchy, the knowledge of one skill is prerequisite to another. In information processing, the outputs of one operation are required as inputs of another. If the subskills of the task are not interdependent, then neither an information processing nor a hierarchical approach are appropriate.

The learning skills can be listed from these two formal approaches and presented as alternative ways to analyzing tasks. Other more specialized types of task analysis may be appropriate for different subject areas.

In setting performance goals, there is a critical dependence on task analysis. Once the task is analyzed, the learner should try to break it into "step-size" goals which he judges to be appropriate to his own abilities.

When an individual manipulates his environment to produce changes in his own behavior, this is called self control or self monitoring. The essential procedure for self control is for the subject to identify the behavior he wishes to control and conditions under which it is likely to occur, and then to find every feasible way to manipulate these conditions (Reese, 1966).

The research analyzing human operant behavior is composed of case studies in clinics and in classrooms where the teacher analyzes specific problems and sets up a contingency management system. There are also helpful manuals which are adapted to the special needs of parents, teachers,

and students to explain the principles of behavior modification, and strategies for general classroom management and individual behavior management (Madsen and Madsen, 1970; Homme, 1969; Becker, Engleman, and Thomas, 1971). However, there is very little research directly related to the learner manipulating contingencies to control his own behavior. The practical applications of behavior theory have been biased toward teacher control with the learner viewed as an object of management rather than a self manager.

There are obvious advantages to self management. A possible positive outcome of management can be increased feelings of self-confidence and self-esteem. The learner will be more confident about the task he has set for himself and the rewards are more likely to be effective when he has selected them himself. Self management should result in a decided increase in initiative toward independent study.

There are many unresearched questions regarding self management. When should a child begin to take responsibility for managing his own behavior and what are the steps required for the process of turning over the responsibility of his learning to the child? It is certainly not practical for a classroom teacher to allow all the children to begin to monitor their own work and set up their own rewards at the same time.

Implications from research indicate that the learner should gradually take the responsibility of managing his own behavior. Some teachers use a fading technique to gradually decrease extrinsic rewards and gradually increase the time intervals between rewards.

Homme (1969) suggests a contingency contracting plan in which the student is his own contractor--a process called self contracting. He offers this as a concrete way to teach self management. Homme also suggests beginning with some agent other than the student determining both the task

requirement and the length of reinforcement time. The difficulties to be encountered in bringing a student eventually to the point where he determines these factors for himself are, at present, not well known.

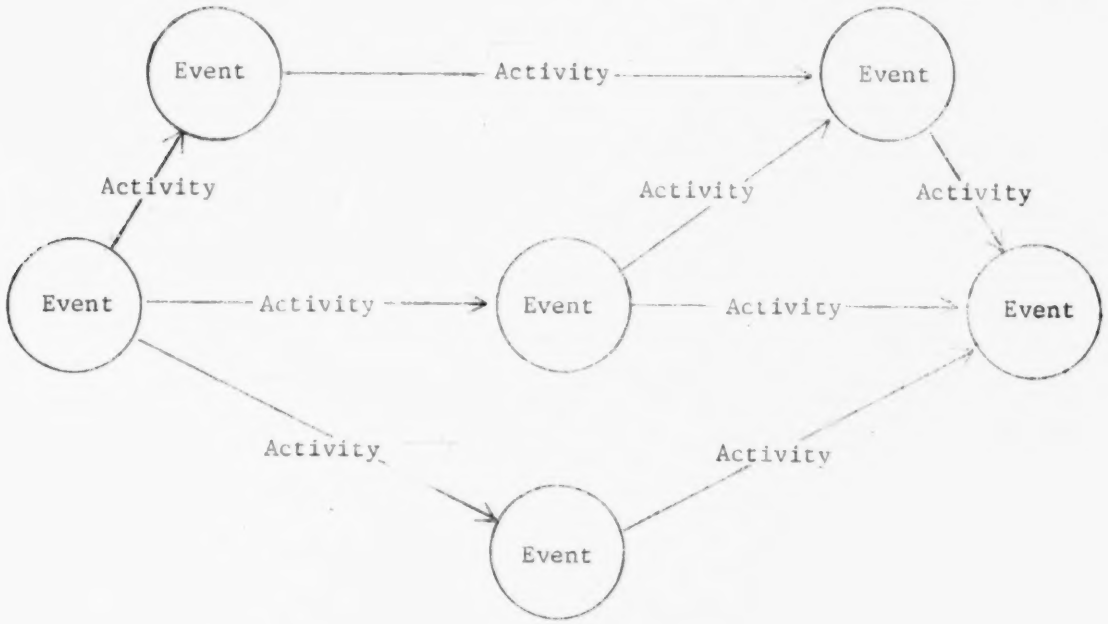
Homme (1971) presents an analysis of the ways in which the contingency contracting system may lead to successive approximations of self management. The ultimate goals of contingency contracting can be defined as getting the learner ready to establish and fulfill his own contracts and to reinforce himself for doing so.

Planning a task/time schedule involves a set of skills which have played an important role throughout the growth of our technological society. Many approaches which were oriented toward designing new military systems or developing new products can be learned by students as methods of accomplishing school tasks or personal objectives. It is desirable for students to experience some of the principles involved in these efficient methods (Cook, 1964).

One such method is PERT (Program Evaluation and Review Technique). This is a planning and control technique which can be applied to projects which have many interrelated tasks. It is designed to (1) evaluate progress toward the attainment of project goals, (2) focus attention on potential and actual problems in the project, and (3) determine the shortest time in which a project can be completed. Specifically, it is concerned with the identification of each goal in the project and the time required to complete it (Cochran, 1969).

The circles in the following figure represent events which are connected by lines denoting the necessary activities (how to accomplish the goal). Activities that can be conducted at the same time are drawn parallel to each other, while those that follow in sequence are connected end-on-end. This

network is the fundamental analytical device which distinguishes the PERT plan.



Next, it is necessary to secure estimates of the time (days) which are required to achieve each subgoal. In the PERT network, three time intervals are designed for each task. One is called "most likely time" and the period that would be expected to complete the job under normal working conditions. A second is an optimistic estimate, completion time if everything goes extremely well. The third is a pessimistic time that incorporates every delay that might happen. From these three, the "expected time" can be computed (Cochran, 1969).

The theory of this task/time analysis can be reduced in scope and made feasible for even elementary students to plan tasks and break down their task into steps and estimate how long each step would take. Intermediate grade children can treat assigned or chosen social studies projects in this manner. They will receive great reinforcement by committing their plans to paper in some formal fashion, and then checking off their tasks as they are

performed. They will not tend to get discouraged with longer tasks when they cannot complete them in one day.

The learner should be acquainted with the principles of strengthening, weakening, and maintaining behavior. Knowledge of principles of reinforcement will increase his ability to properly manipulate circumstances in his own behalf. It will give the learner a sense of control over his own life. He will be able to change some behaviors on his own if he understands the contingencies affecting the situations (Brown, 1961).

The learner should be able to attend to the task he wishes to accomplish. Studies of teacher's reinforcement schedules to maintain the attention of young children on a given task are numerous. Some of the most illuminating material on the nature of attention is found in the studies of distraction. At first thought, distraction might seem the opposite of attention. Yet it is really spontaneous attention to the distracting element, given because the conditions attracted it and not because the learner consciously decided to attend. When we say attention is akin to distraction, we simply mean that some stimulus which we think should not be there has stronger attention-claiming power than the stimulus to which we think should give attention. Where our attention goes depends on the balance of strength between that stimulus to which we think we should attend, and the distractor which claims involuntary attention (Egeth, 1967).

A number of studies have indicated the kind of things people find distracting. Sounds such as a clock's striking or doorbell's ringing cause a consistent increase in the number of errors made and in the time required for learning. The sounds of drumming on the table with a pencil, laughter, scraping chairs on floors, and whistling, lower efficiency in spite of a favorable set for work and an increase in effort. Radio and television

have a similar effect on quiet work such as reading for most children, though there are great differences among individuals in the nature of the stimulus that causes distraction. Noise that is constant or random, however, does not affect the level of mental performance on simple tasks (Berlyne, 1960).

A second area of research has to do with compensatory mechanisms in fighting distractions, and with the levels at which they are effective in preventing loss in learning during distraction. Some investigators find loss in learning with any kind of distraction, such as a standing rather than a seated position, flashes of light, humor, lip movement, electric shock or threatened shock, or loss of body support. The loss is shown both in errors made and time needed to attain mastery.

Many studies show great individual differences in response to distraction and suggest the importance of helping pupils become accustomed to working in distracting situations similar to life environments. Others find that if performance is to remain stable under distraction, increased effort is required. Under distraction, learners talk louder, make more overt movements, vocalize, and in general expend more energy to produce the same level of performance (Seague, 1972). From the experimental evidence, it seems that:

> What the individual finds distracting varies with its newness to him. The city dweller is kept awake by bird calls in the country, the country dweller by street noises in the city. Novelty claims attention.
>
> What the individual finds distracting varies with its depth of meaning for him.
>
> Where attention goes is determined by the relative strength of the competing stimuli for the individual.
>
> Whatever the nature of the distraction or its intensity, its counterpull takes a toll from the attention the learner is trying to give.
>
> Performance can sometimes be kept at a high level under distraction by increased voluntary attention, but more energy is needed to maintain performance.

Self-charting skills are essential to the self-monitoring process. The learner must understand how to measure his academic or social behavior if he wishes to extinguish a particular behavior or reinforce another behavior.

Ojerman (1964) describes a method of self-charting for elementary children. The teacher reads stories to the children about behavior situations. Sometimes the stories are unfinished and the children are asked to supply possible solutions. The problem situations are about things which could possibly happen in a school day. The learner records in diary fashion the problems of his day in school and answers a set of questions which lead to analyzing his own behaviors. He is asked to list other solutions to the problem other than the one he chose. Thus, behavior alternatives are considered. These personal solutions are shared in class and discussed.

Many behavioral studies point out to classroom teachers how to control behavior of children by setting up rules and rewards and ignoring or disapproving of behaviors which are undesirable. However, it is a much more difficult task for the learner himself to take the responsibility for changing his own behavior. He is consciously aware of the system he is imposing on his own actions.

A learner can be taught to define a social or academic problem and record the frequency of occurance. If he wishes to extinguish the behavior it might be helpful to discuss the frequency chart he has made with someone and try to analyze what is reinforcing the behavior. The self-charting process is sometimes sufficient reward for the learner. If he can see a steady improvement in his behavior, his self-confidence and his self-esteem are adequate rewards.

Teachers can gradually introduce the concept of self-monitoring by

giving freedom to chart their own behaviors and choose their own rewards to learners who show independence. For a time, the teacher might keep records and compare with the learner in order to check his self-monitoring ability (Becker, Engleman, and Thomas, 1971).

Different behaviors are appropriate in different situations. In each situation certain behavior management systems are operating. A learner should identify the contingencies and rules operating in a given situation and plan his own actions accordingly. A learner who maintains a consistent type of behavior at a party and at work, will be disappointed in other peoples' acceptance of him. It is important to adapt to existing behavior management systems when it is necessary.

Another way in which behavior is strongly influenced is that of modeling, or learning by imitation. A child doesn't dress up in her mother's clothes and high heels because she has been taught to do so; she is doing as she has seen her mother do. It is by modeling that we learn how to behave in most unfamiliar situations. When a person is attending a social function to which he has never before been, he most likely will look around and see if he is acting with the same manners as the other guests (Mager, 1968).

Most of the studies which emphasize the teaching benefits of modeling are done by social learning psychologists or in speech clinics. Bandura (1965) concludes after experimenting with the effects of modeling for many years that:

> In our research at Stanford University, we have found that almost any learning outcome that results from direct experience can also come about on a vicarious basis through observation of other people's behavior and its consequences for them.

Among the conclusions that can be reached from Bandura's modeling experiments are these:

1. Students learn more by imitation if the model has prestige (for the student)

2. The student will perform more of what he has learned if he has seen the model being reinforced rather than punished for that performance.

3. When a student sees a model being punished, the student will not tend to engage in the kind of behavior that was punished.

4. When a student sees a model doing things he shouldn't do, and there is no aversive consequence to the model, there is increase in the probability that the student will do those undesirable things.

The research on modeling tells the learner and the teacher that to maximize subject matter approach tendencies in the learner, the teacher must exhibit those behaviors themselves (Mager, 1968). One of the chief benefits of multi-age grouping is the constant modeling which takes place between older children and younger children. It has been demonstrated that a group of kindergarteners do not exhibit the crying homesick behaviors they usually have at the beginning of the year if they are a part of the multi-age group. Other behavior problems are automatically solved when older more mature students are allowed to learn with younger students. The unnatural separation which the present grade system perpetuates does not maximize the modeling possibilities.

2. LOCATING INFORMATION

Man's quest for quicker, more efficient, and easier techniques for accomplishing his living tasks has caused a developing complexity of technology. Today's learner is faced with a "knowledge explosion." New information is evolved and discovered with increasing rapidity. In addition, much of the historically accepted knowledge is being altered or completely refuted, as illustrated in the entire area of space study.

The trend in science and social studies curricula is moving away from factual learning and going more toward learning principles of problem solving, methods of discovery and strategies such as how to locate information on a given topic. The expansion of knowledge today makes it necessary for the learner to be able to get information independently. Locator skills have gained a high priority as a part of the basic skills necessary in order to learn how to learn.

The learner is faced with numerous and varied sources of information. Many of them are found in the library. There are reference sources, encyclopedias, The World Almanac, Who's Who, Who's Who in America, Atlas, Bartlett's Familiar Quotations, Book Review Digest, American Men of Science, Vital Statistics of the United States, and many others which contain specialized information. There are books and pamphlets which include information about specific topics. The library also contains periodicals such as U. N. Review, The National Geographic Magazine, Time, Newsweek, U. S. News and World Report, etc. (Smith, 1957).

Other valuable sources of information, perhaps somewhat neglected by schools, can be obtained through State and National documents, bulletins, and pamphlets. Local businesses often furnish written and verbal information to

students. Community resources are abundant, including agencies and people who are often willing to give demonstrations of processes or provide written information. Community resource films are often kept in the library (Karlin, 1964).

Once the learner is aware of the available resources, he must then determine the best sources for a given problem, topic, or question. This skill comes with careful instruction and practice in use of the resources (Shepherd, 1965).

The learner who refers to a source of information is usually conducting research in a specific topic within a unit of study in his class. The research may be extensive and require searching through many sources of information; or it may be minimal, requiring only a small bit of information from one source, such as the population of a country or its capital. But regardless of its scope, the research requires prior knowledge and facility with certain skills (Blanchard, 1964).

Choosing key words or phrases, which should be used to locate information about a topic, is a basic skill. For example, if a learner were to locate information about "converting salt water to fresh water" the key word would be water. When the learner locates the word water in an index, he will look to see if a sub-topic under his key word is "converting salt water to fresh water," He may find also, that the word sea or ocean, and not water, is the key word needed to locate his information. The problem is then more complicated. The point to remember is that even though a learner has a topic and a basic knowledge of an index, he may not be able to locate his information if he cannot determine the key words, sometimes called entry words, to use to enter the index (Shepherd, 1965).

Certain specific skills are assumed for the proper use of sources of

information. The learner must know more than merely what sources to use, he must also know how to use them. There are certain specific skills common to nearly all sources which may serve as a core of competence.

The learner should have mastered the ability to use alphabetical order, guide words, the Dewey Decimal Classification, the card catalog, and The Reader's Guide to Periodical Literature. Other prerequisite skills include the ability to differentiate between factual sources and fictional sources, the ability to list a source of information properly in a research paper, and the ability to skim rapidly over materials to locate relevant information.

Let us analyze the task involved in researching the following problem. Why are the trade routes basically east-west in direction rather than north-south? The sources of information are the Atlas, periodical articles about world trade, and general references. The learner is not asked merely to find the principal trade routes of the world, but rather to determine why the trade routes are basically east-west in direction. The learner will have to think through his problem and determine the reasons for trade and the conditions necessary to it. After discerning the conditions of trade, he will need to formulate conclusions to explain east-west direction of trade. Obviously, the key word would be trade, with a possible secondary term, east-west.

To locate information about the conditions of trade, the learner will need to examine general references on trade. The skills of using the card file, using parts of a book and skimming are important. If the learner uses periodicals, he will need The Reader's Guide to Periodical Literature. His key word is trade. He must realize that the Guide is arranged alphabetically by subject and author. Also he needs to know how to interpret a reference in the Guide. He must understand the abbreviations and be able to use the

list of abbreviations in the Guide as an aid. For instance, such abbreviations as il. and diag. tell him that illustrations and diagrams are included in the article.

In his use of the atlas, the learner must know how to gain information from maps and tables. He should realize that the atlas will provide him with specific information which he will then use for drawing conclusions to answer his problem (Shepherd, 1960).

The above analysis of the task involved in researching one problem indicates the large number of subskills necessary to engage in research. In order for the learner to do independent research, he must possess a basic number of locator skills which in turn will allow him to pursue his own interest without the help of an instructor or a classroom situation. This type of learning is more likely to continue when the learner is not in school.

3. PERCEIVING WRITTEN ORGANIZATION

Different writers use different styles or patterns of writing in accord with their purposes and the nature of the materials they happen to be writing about. In general expository writing the following patterns are commonly used: (1) chronological order, or the presentation of the content in a time sequence going from event to event in the order of their occurrences, (2) spatial arrangement, or the telling of events according to the location of their occurrences, (3) cause and effect, or the telling of a cause for something and then delineating its effects, (4) camparison and contrast, or the pointing out of similarities and differences in people and events, (5) opinion and supporting argument pattern or an attempt to explain the sources for the justification of the beliefs stated, (6) question and answer, or the pattern where the author directly states or indirectly implies a question and then proceeds to answer the question, (7) analogy, or the attempt to explain the unfamiliar by comparing it with the familiar, (8) classification, or the sorting of things and events into logical categories, (9) conclusion and proof, or the stating of a conclusion the author has made and then offering proof of its validity, (10) problem and solution, or the posing of a problem and then presenting one or more solutions of it, (11) deductive, or going from a known or accepted principle and applying that principle in reasoning, and (12) inductive or the presentation of a series of related information and drawing a generalization from that information (Smith, 1972).

These writing patterns are not mutually exclusive. Moreover, it should not be inferred that an author will stay with one pattern within a book or

an article. Most often there will be a dominant pattern running through a chapter or article, but shifts in patterns will be made according to the teaching needs of the writer. Certain patterns differ in frequency of use from subject to subject. Learners need to be able to recognize them and to apply different skills to these different patterns (Smith, 1964).

Nila B. Smith (1965) has identified the most common writing patterns used in social studies. Among the most common patterns found were (1) the cause and effect pattern, (2) the comparison pattern, (3) the sequence of events with dates pattern, (4) the detailed statement-of-fact patterns, and (5) the propaganda pattern.

The cause and effect pattern of writing occurs with high frequency in the social studies and particularly in history which is really a study of events, their effects and their causes. Learners need to be able to detect this pattern rapidly and on meeting it to follow the historical chain of causes and effects.

The comparison pattern is often found in political science writing where forms of government, political parties, and government leaders are compared. Upon identifying such a pattern the learner should read to look for comparisons and infer the author's purpose for using them.

The sequence of events with dates is another writing pattern common to history. In reading texts using this pattern the learner needs to organize the dates and events into blocks and to learn key dates and events while thinking how one event influenced another. Many good readers make a time line using key events and the chronological order in which they occurred.

The detailed statement-of-facts pattern is generally found within sequences of other patterns used in social studies writing. While the facts

are not as dense as in the social sciences, students must learn to recognize this pattern as used by social studies writers and adjust their speed as they associate the facts with causes and events.

The propaganda pattern of writing uses reasoning fallacies in an attempt to persuade, delude or trick the reader. Such writing patterns tend to use such devices as unnecessary emotionally toned words; circular reasoning; either-or reasoning; false analogies; appeals to conformity; conventional thinking (everybody knows that---); false issues, confusion of the part with the whole, stating opinion as fact; the use of stereotypes; improper statistical interpretations; and using words whose meaning shifts within the same context (McCall and Smith, 1964; Baaman, Hogan, Greene, 1961; Jenkinson, 1968; McCall, 1961; Smith, 1965; Whipple, 1964).

Special writing patterns have also been identified in mathematics. Mathematics writing is noted for compactness accomplished partially through use of symbols. Using a mixture of symbols in the same paragraph is common in mathematics texts. Some paragraphs contain word symbols, number symbols, letter symbols, and geometric symbols. The interpretation of such a variety often makes for difficult reading (Lerch, 1967).

According to Smith (1964) the most highly specialized pattern of mathematical texts is the short paragraph containing a problem situation. This is called the problem pattern. The problem is usually stated by first giving the situation or conditions under which the problem took place. Then there is usually a series of numbers or other mathematical values given. Last, the reader is asked or told what to find. The reading of such a pattern involves the reading of the entire problem to grasp the whole situation, concentrating on the statement (usually at the end) that asks or tells what to find, deciding what process or formula to use, and pulling out the facts or symbols for use in working the problem.

The second pattern discussed by Smith (1964) is the explanatory pattern. In mathematics as contrasted with science, most of the explanations are short and given in one section of a chapter rather than spread throughout the chapter. Usually there is an example of a problem worked out for the reader. Learners should be taught to paraphrase the explanatory patterns and to identify and order the steps required to work the problem (Bell, 1965; Bond, 1957; Buswell, 1931; Dechant, 1965; Lerch, 1967; Repp, 1941; Smith, 1969; Smith, 1964; Smith, 1965; Willmon, 1971).

An analysis of science textbooks reveals that they, too, contain specialized patterns of writing. One type of science text falls into the classification pattern in which living things, objects, materials, elements, gases, liquids, forces, etc. are classified under a common heading which in turn deals with sub-divisions. In reading this pattern, the learner who identifies it as a classification pattern will concentrate on grasping the sub-divisions and the chief characteristics of each one.

Another pattern of writing which is particularly characteristic of science and perhaps the most difficult one to read is the explanation of a technical process. This is usually accompanied with diagrams necessitating very careful reading of text with continuous reference to diagrams.

A third unique pattern is one in which instructions are given for carrying out an experiment. This pattern consists of explicit directions that must be carried out exactly and which call for careful observation of what happens, an explanation of what happens and the drawing of a conclusion.

Also frequently encountered in science textbooks is the detailed statement-of-facts pattern. This differs from fact-giving text in other subjects in that the facts are more dense, and they frequently embody a definition of a statement of a principle.

Grasping the meaning of the symbols and abbreviations that are integrated with words in the text calls for special reading skills. Thus reading abbreviations and equations is also a special science reading pattern.

Patterns of writing in the field of literature have been established for years. They are usually classified in terms of the author's purpose. There are the story; essay; drama; biography; fable; and poetry of many kinds, some written in blank verse and some rhymed verse and of many different meters.

These different types of literature are generally read for a different purpose. The story or novel is most often read to enjoy the plot. The essay is read to get the author's view on something. Plays are read to interpret the conversations of the characters and to visualize the settings and the characters. Biographies are read to get an impression of the person the author is writing about. Poetry varies in the purpose for which it should be read and in the form in which it is written (Smith, 1965). In dealing with each of these purpose patterns the student must learn to determine the author's purpose in writing and deduce the reason the author chose the particular literacy form for his purpose (Smith, 1965; Bivens, 1965; Burton, 1964; Dunning, 1964; Jenkins, 1964; McCall, 1964; Richards, 1929; Squire, 1963).

4. READING WITH FLEXIBILITY

Skimming and scanning are considered forms of selective reading. In contrast to intensive reading where one attempts to get an indepth knowledge about the author's subject, skimming is an organized search to get an overview of a book, chapter, article, or paragraph. Skimming to preview a book often involves looking over the title page; reading chapter titles; reading headings, subheadings and words in special type; first and last paragraphs; and, depending upon the patterns of writing used, parts of the paragraphs containing key sentences (Spache and Berg, 1955; Pauk, 1962).

Skimming for the main idea in paragraphs involves the rapid detection of the author's style of writing, and it involves the recognition of key words. It also calls for the skipping of words and sentences that lead up to the main idea or which are used to elaborate the main idea (Smith and Guice, 1972).

Quite contrary to what most people think scanning does not involve the act of reading. Scanning means looking very rapidly over a paragraph in order to find the answer to a question in the reader's mind. For example, one may wish to find a person's name, a date, or the name of a city. Sometimes the learner may wish to find quickly a phrase or a general idea whose wording is not known. In such an instance skimming may be used to locate the unit or portion of a chapter or book where the phrase or idea is most likely to be found, and then the technique of scanning could be used to find the specific material wanted (Spache and Berg, 1955)

Research findings indicate that training in skimming and scanning is profitable for the learner. Once the learner understands the concepts involved in skimming and scanning, practice is valuable (Spache and Berg, 1955; Smith and Guice, 1972).

The major technique of surveying presented by Francis P. Robinson in his book Effective Study is known as the SQ3R method -- or as extended by Miller and Seeman (1964), the SQ4R method. These methods are alike with one exception. The SQ3R does not contain the fifth step: REPEAT steps 2, 3, 4.

The first step is SURVEY. Glance over the headings in the chapter to see the few big points which will be developed. This survey should take only a few seconds and will show the several core ideas.

The second step is QUESTION. Turn the first heading into a question. This will arouse the learner's curiosity, and thus aid comprehension. It will help bring to mind information that is already known. In this way the learner's understanding of that section will be increased. The question will make important points stand out.

The third step is READ. Read to answer the question. Make this an active search for the answer. The learner will find that his eyes tend to move more rapidly over the material, slighting the unimportant or explanatory details while noting the important points.

The fourth step involves RECITING. The learner should try to recite the answer to the question without looking at the book. This should be done in the learner's own words, using an example if possible. If this cannot be done, the section should be reviewed again, and if possible, some notes taken for review and study at a later time.

REPEAT steps 2, 3, and 4 on each succeeding section. Turn the next question into a heading and recite the answer by jotting down cue phrazes in an outline. Read in this way until the lesson is completed.

The sixth step is REVIEW. The learner should look over his notes and attempt to recite the major subpoints under each heading as a check on his memory. This checking of his memory can be done by covering up the notes and trying to recall the main points, then exposing each major point and trying to recall the subpoints listed under it (Miller, 1942; Robinson, 1964; Miller, 1964).

A modification of this method to apply to mathematical type reading where problem solving is involved may be summarized as follows. The first step is SURVEY. The learner should look over the problems to see what types of logic they require and what basic formulas will be used. Associations should be made, if possible, with practical problems.

The second step is QUESTION. The learner should look at the first problem, think it through to be sure he understands what the unknown and known factors are. Sometimes these can be listed in separate columns.

The third step is simply to SOLVE for the unknown factor.

CHECKING may be done by substituting the answer found for the unknown in the original statement to see if it makes sense. The learner may also check through the basic formula to see if it balances with the value. The same three steps are REPEATED for the successive problems in the assignment. Then the learner should REVIEW and check.

A question frequently asked of the reading teacher is "How fast should I be able to read?" There is no one answer to this question because, "... the reader's rate should vary according to the kind of material he is reading and the thoroughness with which he wants to read it" (Harris, 1966).

One can suggest a typical or normal rate for one specific kind of material, but that rate will only be valid for the kind of material used in establishing it. For example, the "normal" rate for reading a comic book which would call for rapid type reading would differ greatly from the rate at which one would read science, which would require careful reading to understand the content.

Versatility in rate is important and it is necessary to teach learners that no one rate of reading is appropriate for them on all subjects or even within a material. Appropriate speed depends upon the purpose of the reader, the nature of the writing, the density and abstractness of content, and the pattern or patterns of writing employed by the author. It would seem that most readers would recognize this and that flexibility of rate would develop "naturally." However, many readers tend to develop one rate of reading which they then apply to most of the things that they read (Gates, 1952). This inflexibility tends to develop at the third and fourth grade levels (Nason and McDonald, 1964) or at the levels where serious content reading is most often introduced. Teachers appear not to be aware of the inappropriateness of transferring "general reading speed" to subject matter reading or of differentiating time allowances from pupil to pupil in their assignments. One textbook assignment and rigid time allowances tend to result in a failure of pupils to develop flexible reading rates. Some learn to "cover the material" rather than to learn and associate the content with other related information that they already have.

Reading flexibility is affected by two main factors, the reader's purpose and the difficulty of the ideas, concepts, vocabulary, and style of material (Fry, 1963; Smith and Guise, 1972).

There are many purposes for reading that may influence the speed with which the reader performs: Reading for the main idea, reading just to identify sequence, reading to classify materials, reading to master specific facts, reading to locat information, reading to locate a telephone number, reading directions, reading to locate a dictionary entry, reading for relaxation. These purposes do not necessarily dictate any particular rate of reading. The rate would vary widely with an individual. It is important to note that speed reading courses apply to few of the purposes for reading. The learner must adjust his normal reading rate to fit the purpose at hand.

It is possible that the learner may have developed some habits which may interfere with his fluency and flexibility of reading. Lip movement and subvocalization are natural offsprings of learning to read by an oral method (Herrick, 1963). Other habits which may interfere with flexibility are finger pointing and head movement. A reader may also make a large number of regressions when reading material that is heavily loaded with unfamiliar words, peculiar or highly involved sentence structure, or very difficult ideas (Herber, 1970).

An important learning skill is to make the reader aware of the factors involved in reading level. He will avoid frustration if he recognizes that a particular selection has an unusually difficult sentence or a highly technical vocabulary. The learner must be taught the skills involved in adjusting his reading rate to the difficulty of the material (Smith and Guice, 1972).

Little research has been done to determine and describe the concept density of reading selections. This would be especially important with learners who have mastered decoding skills but tend to have difficulty with context processing.

5. PRODUCING ORGANIZATION

Miller (1956) observed that the process by which people translate information into their "own words" plays an important role in learning and perception.

Evidence obtained by Bartlett (1932) and by Allport and Postman (1947) shows that individuals play important roles in interpreting and encoding meaningful information. Howe (1970) believes it is possible that the reproduction undertaken in notetaking in particular may have positive effects on retention.

Howe (1969) and Kay (1955) found a positive correlation between the efficiency of notetaking and the success of subsequent recall despite the presumed individual differences in what constitutes the most efficacious notetaking strategies for individual subjects.

Repeated studies support the idea that notetaking is a valuable aid to learning in any situation where there is delay between exposure to the material and testing on the content of the material, regardless of the type of testing used (Carey, 1935; Crawford, 1925; Breene, 1934; McClendon, 1958).

Notes appear to serve either or both of two functions (DiVesta, 1972). As an external storage mechanism (Miller, Galanter, and Pribram, 1960) they can provide a resource for later study or reference by the learner. As an encoding mechanism they allow the learner to transcribe whatever subjective associations, inferences and interpretations occurred to him while listening.

Notetaking used solely for purposes of external storage is incompatible with efficient learning. As an external storage mechanism notetaking, outlining and summarizing cannot be considered learning applications.

A learner who takes notes, outlines or summarizes in a mechanical fashion may feel that the learning task has been accomplished. He might feel that a "good set of notes" is the equivalent of studying.

The behavior of the student employing encoding reflects a transaction between the learner and the material to be learned. It assumes or suggests an active learner. In a sense, the learner has taken the initiative necessary to put the material into long term store. Through encoding, the learner has linked the material to his existing cognitive structure--he has made it meaningful (DiVesta and Grey, 1972).

A sense of order and classification and the ability to discriminate and subordinate are essential to the organizational skills of outlining, notetaking and summarizing (Courtney, 1965).

The degree of proficiency with which one engages in these learning applications depends on the extent to which he has mastered the learning skills which involve ordering, classifying, discriminating and subordinating ideas. Other learning skills which involve attention and memory are also related.

Experts and researchers in study skills consistently recommend a large loose leaf notebook as the best material for notetaking, outlining and summarizing (Bird, 1931; Bird and Bird; 1945; Dolan, 1945; Estabrooks, 1927; Headley, 1926; James, 1967; Pauk, 1962) They further recommend writing only on one side of the paper (Bird, 1965, Pauk, 1967). This allows ample space for various techniques of organizing notes, outlines and summaries.

Certain procedures are suggested for taking notes which would provide students adequate material for later referral during private study and preparation for exams. These procedures apply to notetaking from books and lectures.

All notes should be labeled as to topic, time and referent (Courtney, 1965). If possible the notetaker should be familiar with the content from which he will be taking notes. If the notes are being taken from a book, a brief survey of the book should be made as to content and style of presentation of information.

Plamatier (1970) suggests that a consistent format be followed. Individual preferences should dictate the format used. Earlier studies suggested formal outline structure, but this has proven inefficient since much of the student's time is spent in thinking about the form rather than interacting with the material being presented.

The learner may find it helpful to be familiar with various forms of taking notes, such as the double column form used by some science students (Courtney, 1965).

Rather than massive direct quotes, notes should be taken in the student's own words (Farquhar, 1960). Because speed is important, the student should attempt to develop a set of personalized abbreviations and symbols (Courtney, 1965).

The most important procedures for notetaking involve listening for key ideas. Armstrong (1956), Farquhar, Krumboltz and Wrenn (1960) suggest some lecture cues indicating main ideas.

1. Check course outline for topics or objectives to be covered in a class lecture.
2. Check the blackboards, charts, maps, etc. for the main points.
3. Opening statements often contain overviews of lectures.
4. Listings such as first, second, and third often give a hierarchy of the main points.

5. Pauses and changes in voices often indicate transitions from one point to another.

6. The lecturer's simple statements such as "This is important" or "Remember this point" indicate key ideas.

7. Summary statements or conclusions often review the essence of the lecture.

It is necessary for the good student to review notes at the end of a lecture in order to organize them and edit them. At this point it is important to be sure the notes are sufficiently complete to be intelligible at a later time. Farquhar (1960) found no evidence that learning occurs when notes are copied. Some students underline the main points or parts they wish to recall. Others may summerize the key ideas in the margins. There is little research evidence supporting these activities as aiding retention comprehension (Woodhouse, 1970).

There are certain advantages to taking notes from written material. The factor of time is removed. The student may take notes at his own pace. He may reread if necessary. The material is available for review and correction if notes are unclear (Farquhar, 1960).

Outlining may be considered a learning application if the student is actively thinking through the material he is working on as to its organization structure and key ideas. Otherwise outlining is a mechanical external storage mechanism.

Very little research has been done on outlining as it affects learning and retention. The procedures listed below are generally recommended and suggested by the expert advice in the literature.

The learner's first concern is to discover the organizational structure of the material to be outlined. Sometimes bold headings and dark print help. The learner needs to be familiar with a number of organizational patterns commonly used.

Nila Banton Smith (1964) listed the following patterns: (1) chronological order, or the presentation of the content in a time sequence going from event to event in the order of their occurrences, (2) spatial arrangement, (3) cause and effect, (4) comparison and contrast, (6) question and answer, (7) analogy, (8) classification, and (9) problem and solution.

There are other patterns which are common to specific subject matter fields (Smith, 1964).

These organizational patterns will form the skeleton of the outline. The learner must recognize the main ideas which develop the organizational patterns. They will be placed as main headings under the structure of the organizational pattern. The subordinate or supporting details appear as subtopics to be classified under the main headings.

It is assumed that the learner is familiar with the standard form for outlining. He must then take the organizational structure he has perceived and place it into outline form.

By carefully considering the purpose of the outline, the learner will judge appropriately the level of detail necessary.

Summarizing calls for looking more carefully for interrelationships between the various parts of the test. The goal is to make the reading material clear and to organize all the parts into one interrelated whole (Farquhar, 1960).

One procedure for summarizing material is to ask and answer broad organizational questions (Farquhar, 1960). When summarizing shorter selections or paragraphs it is sometimes appropriate to choose the best sentence from the paragraph or group of paragraphs. This works only, of course, if the main idea is explicitly stated. If it is implicitly stated then the learner may try to state the author's idea in a single sentence.

Other procedures for summarizing involve restating paragraphs by combining the author's ideas into shorter statements. Some types of summaries may be made by recognizing different types of paragraphs and their functions and making summary statements to this effect (Smith, 1964).

6. LEARNING WITH OTHERS

Much of the learning done in school is accomplished in groups. These groups may vary from one student tutoring another, to group discussions held by the teacher. Many students take naturally to the group learning environment, while others need to be taught the specific learning skills involved in contributing to groups, listening in groups, and in other more specialized group methods such as brainstorming or role playing. These skills involving learning with others can be operationalized, taught, and evaluated. Learning skills involving interaction with others should be realized as a part of the curriculum.

From an early age it is essential that the learner recognize variance of opinion so that he is capable of accepting a conflict of ideas. All through life it will be necessary for the individual to make choices. To do this he must evaluate what he learns from others effectively and critically. In a democracy it is necessary for the learner to identify common goals with his peers, and yet maintain a degree of flexibility (Rugg, 1963).

The learner will need to know how to consider opinions, to be scientific in making decisions, to be able to communicate his own ideas, to be able to assume leadership or followship as the situation demands, and to plan intelligent actions. These techniques will aid the learner in contributing and listening in groups, and will transfer to the development of desirable group living behaviors.

The learner will also need to understand when to think intellectually and when to think emotionally, and when to conform and when to express

individuality. There are times when the learner must take certain interpersonal risks by contributing personal experiences, impressions and feelings, or by questioning to clarify his own knowledge. He needs to be rewarded for these risks by members of the group. They can reward him by attentive listening, positive facial expressions, and recognition and appreciation of his personal contribution.

Various studies of group dynamics have led to some interesting facts about conformity and creativity in groups. It is important for the learner to be aware of these facts and keep them in mind when group processes are operating (Lundington, 1958).

1. Learners conform more when their actions affect other people than when they themselves are the only ones affected.
2. Learners conform more when they consider the task of the group is important and relevant to the group's goals.
3. Learners who feel rejected by the group conform more than people who feel accepted.
4. Status differences within a group increase conformity, discourage deviate opinions, and reduce the effectiveness of group work.
5. Participation in decision-making can change the direction of group goals and conformity pressures.
6. The introduction of expert opinion to support an opinion tends to increase the amount of conformity to that position.

Learners must realize that some conformity is necessary in order to develop democratic processes. At the same time, creativity and individuality are necessary for group processes. He must discriminate between situations in order to identify what behavior is appropriate at a given time.

One technique that has been used to promote creative nonconforming responses is brainstorming. There are some basic ground rules about

brainstorming which must be followed in order for it to be successful. First, the problem that needs a creative solution must be carefully defined. The scope of the problem must be limited and all participants must understand it completely.

Second, a noncritical, informal, nonjudicial atmosphere must be established in the classroom. No negative comments or criticisms are to be accepted and judgement will be deferred. No one is to consider anyone else's ideas as useless or silly. To do so may cut off the flow of creative ideas. Unusual or bizarre ideas are encouraged. The problem is posed and each person raises his hand if he has an idea. The objective is to obtain a large quantity of ideas in a short period of time. The ideas may be written on the chalkboard. After the brainstorming has stopped, criteria are applied to the ideas to evaluate them for a possible solution (Clark, 1958; Fielder, 1962).

Other group procedures which require more conformity for participation by the learner are panel discussions and group discussions. Specific decisions have to be made with regard to group discussions concerning purpose, procedure, organization and evaluation. Various techniques have been developed for recording and classifying varieties of participation. The teacher can judge from a rating whether his role was too dominant in the discussion, and he can review after the class discussion the type of participation each learner engaged in.

The panel discussion is even more carefully thought through and planned. It provides training for and practice in critical thinking, since it calls for intellectual interaction with others who are expected to be well prepared in their own areas.

Benne and Sheats (1953) and others have identified behaviors, functions, or roles which describe things that people do in aggregates or groups in order to get a task done. Some of these are:

Initiating; stating the group task, stating goals, proposing plans, supplying ideas for the accomplishment of the task making suggestions for the use of resources.

Supplying Information; giving facts, providing data relevant to concerns of the group.

Requesting Information; identifying areas where facts and concepts are needed, asking for suggestions and ideas.

Providing Information; listing possible resource people as materials, bringing in solutions developed in other places using one's own background and expertise.

Requesting Opinion; calling from members expressions of feeling about procedures or ideas, asking for acceptance or rejection of objectives or proposals.

Clarifying; restating ideas of others in one's own terms, questioning proposals, interpreting.

Elaborating; building on ideas of others, restating one's own ideas in more complex form.

Summarizing; restating conclusion or decision and asking for group commitment, calling for vote or general agreement.

Evaluating; reminding group of deadlines, keeping minutes.

Orienting; keeping discussion relevant and on track.

These are but a few of the learning skills involved in participating in and leading groups. These skills are necessary for good communications.

Role playing is a unique process of learning the feelings and thoughts of others. It has tremendous potential for the elementary school learner. By taking the role of another person and by pretending to feel like, think like, and act like another person, learners can act out their true feelings without the risk of sanctions or reprisals. They know they are only acting,

and can thus express feelings ordinarily kept hidden. Learners can examine and discuss relatively private issues without anxiety. These problems are not focused on the self; they are attributed to a given role or stereotype.

By placing themselves in the role of others, learners can identify with the real world and the imaginations of the other students and adults. In this manner they may begin to understand the effects of their behavior on others, thereby gaining significant information about the motivations for their own and other people's behaviors. Achieving systematic insights into self, others, and various groups can aid students in clarifying their own ideas and in effectively directing or changing their own behavior (Chaster and Fox, 1966).

Role playing can be used to demonstrate less personal but pervasive problems between and among people and groups. Social problems, to the extent that they reflect conflict between man and man, can be dramatized fruitfully in the classroom. For example, classroom portrayals of problems of prejudice may lead to greater understanding of the dynamics of this phenomenon and some clarification of methods dealing with its occurrence.

Role playing that helps individuals to understand their own and others' behaviors can free them to utilize their intellectual potential more fully. Substantial research has shown that interpersonal relations and feeling of high or low self-esteem affect a student's academic performance. Thus, role playing directed toward understanding and changing interpersonal relationships may lead indirectly to a higher level of academic performance. It may also be used to present academic materials: historical or contemporary events can be acted out in class to dramatize the feelings and conflicts of the participants in pivotal situations.

Skill practice in role playing can be seen as one technique in an educational procedure that is directed toward the scientific improvement of classroom learning and social behavior. Such a procedure assumes that learning needs to be more than "studying about" and more than mere activity.

Role playing in the classroom works best when there is an attempt to follow a definite pattern. The following sequence allows for logical ordering and development of the role play session. The first stage covers problem selection, warm-up, and general and specific instructions to participants and audience. It involves the selection by the teacher, with or without class help, of an issue or problem for consideration. After selecting the problem, the teacher needs to warm up and relax the learners and give them practice to gain security in public performance and expression.

The second major stage covers both the role playing and the subsequent discussion and interpretation of the action. Sufficient time should be allowed during the improvisation for the learners to become thoroughly familiar with the problem situation so that they can take full advantage of the situation's promise for discovering and practicing alternative behaviors. At the conclusion of the drama it is important to bring the class back to reality and to disassociate the actors clearly from the role they played.

Evaluation must follow the enactment and discussion of the role playing situation. The learners review the successes and failures of their role playing experience. It is also possible to have the audience assigned a role, and they can review their reactions and observations with the participants.

The literature of the last several years reveals schools and projects in increasing numbers across the nation participating in programs in which students tutor students.

> The purpose seems to be to help the tutor, the tutee, or both. Compared to the tutee, the tutor may or may not be older, brighter, or more maladjusted; or a different socioeconomic class; or attend the same school (Thelen, 1969).

Some studies are reporting that by placing under-achievers in the teaching role, both the learner and the tutor make significant progress (Cloward, 1970).

The present research has directed itself to answer questions such as: Are there patterns of cross-age, cross-culture, or cross-ability which increases or decreases the tutoring effectiveness (Malaragno and Newmark, 1969)? Also, are there types of subject-matter areas which more readily lend themselves to the tutoring process?

Learning with a tutor does not seem dependent upon the type of subject matter areas as much as it is upon certain conditions being met in the tutorial program and in the tutoring experience.

The learning skills needed to work in a tutoring situation vary as to the formality of the situation. General tutoring skills needed are: the correct use of positive reinforcement, the ability to put a learner in a tutoring situation at ease, and the ability to avoid over-prompting of the learner. A more formal tutoring situation may involve a tutor log. The log will provide a means of making the following entries: the date of each tutoring session, the tutoring activity for each session, and any learning gains achieved in each session.

In a very specific individualized classroom situation more detailed systems may evolve. The tutor should know how to make instructional prescriptions for individual students. It is important to know how to use the

materials. Sometimes the tutor will need to conduct small group discussions. The tutor should know how to interact with the learner through various questioning techniques. The tutor must avoid over-prompting the learner.

Tutoring sessions have been evaluated by many devices. Some effective evaluation instruments are (Noce, 1967):

1. Informal observation
2. Interviews
3. Questionnaires and surveys guided by common sense interpretations of objectives
4. Inventory sheets requiring the checking-off of objective behavior patterns
5. Rating scales and objective check lists
6. Sociometric devices
9. Personal documents such as autobiographies and diary records
10. Pre- and posttesting in subject areas, personal adjustment areas, attitude and interest areas
11. Case studies

7. DEMONSTRATING LEARNING ON TESTS

Frequently a student is asked to demonstrate his knowledge by taking a test. There are certain principles of learning for test situations which will enable the learner to properly demonstrate his knowledge. Many learners earn lower scores on tests than their knowledge or aptitude warrants because they lack test-wiseness, the ability to use characteristics of tests and test taking situations to reach the full potential of one's knowledge and aptitudes (Pauk and Millman, 1969).

It is assumed that the learner will use the other principles of learning and applications of learning in order to master the subject matter thoroughly. In addition, he needs special cues for learning for tests to protect him from making certain errors which would cause him not to demonstrate his knowledge properly. The principles discussed here will be those which apply to achievement tests, since they are specifically designed to measure how much a student has learned (Pauk, 1969).

The first principle is that of spaced regular review. The material should be learned systematically. Some cramming is undoubtedly, beneficial, especially for reviewing the more specific ideas and facts learned regularly during previous weeks. But the learner should not delay the initial learning of subject matter until just before an exam.

Studying past quizzes and tests will help the learner analyze his strengths and weaknesses. If possible, getting examinations legitimately from previous administrations will help the learner to get the scope of the type of examination given by a particular instructor or institution (Farquehar, 1960).

Becoming familiar in advance with the purpose and format of the test will help the learner to focus time and energy on the particular aspect of a subject that is being tested. The learner should familiarize himself with the kinds of questions that will be asked.

One must know how to schedule his time when taking a test. It is important to know how long is allowed for completion of the test and its parts and how fast to answer the questions. If the student is not aware of how many and what type questions are presented, then he should look over the entire test. A schedule for progress through the test should be determined. With paper and pencil and mental framework all set, the learner should then begin the test.

The principle of omitting items which are not easily answered is essentially the same as the principle of not spending too much time on any one item. Working fast on those items which will yield the most points in a given amount of time is a wise strategy which may mean that the easiest questions should be answered first. The remaining time should be used for reconsidering and improving answers about which there is some doubt.

Testing involves precise communication between test maker and test taker. Students tend to place too little emphasis on the necessity for carefully reading directions and questions. A perfectly well written and correct answer to a question not asked will receive no credit. Frequently, understanding what is asked is more difficult than the idea being tested. The learner should pay particular attention to those parts of the directions which influence how you will take the test. The directions

should answer questions as to the order of answering, the number of questions that must be answered, the type of answer required and the scoring procedure.

The directions should be kept in mind when answering the test items. The learner should not depend on the questions in the test to tell him the nature of the directions. If he is unsure of the directions after reading them then he can ask the examiner for clarification. At all times he should be alert to the questions as they are, not as he would like them to be.

Every word in a question is important. If a question is missed because of misreading, then the learner is not able to show the full extend of his knowledge. Words upon which a precise and accurate interpretation of the question asked and the desired response depend, are the "key terms". Decisions as to which words are key words depends partially on the scope and sequence of the material being covered on the test and the particular interest and slant given by the instructor or the testbook.

Time at the close of the test should be spent on checking interpretations of directions and questions. Many open-ended questions contain several subquestions, and it is these questions and complicated directions which are most likely to be misinterpreted.

Benjamin S. Bloom and Lois J. Broder (1950) suggest certain problem solving techniques which are appropriate for examinations. One research study showed that the willingness of test-wise students to tackle longer questions was one of the factors which differentiated them from students not as sophisticated. The learner should not give up on the questions which seem to require extra curricular knowledge or which contain references to things that are unfamiliar.

It is important to actively think to obtain an acceptable answer to each question. The test-taker should not be satisfied to rely on impressions or feelings or merely to put down a suitable sounding answer or an answer he remembers from his textbooks,classnotes, etc.

To be sure that the right question is being answered, an agressive interrogation of oneself is necessary. The learner should ask himself questions such as: What are the elements or parts of the problem? What are the concepts that apply in this case? What does my own experience tell me that might help in answering the question? Are the instances from my experience relevant? What kind of answer is needed here?

It is sometimes helpful to change the problem into language which is easier to handle. For example, make the question more concrete. In a numerical problem this might mean substituting numbers for abstract ideas and symbols; in a history problem, it might be advantageous to change dates to events. Long and involved problems can profitably be broken down into parts, and by working to find the answers to these smaller parts, the student will be able to better answer the entire question.

After answering the question, the learner should reread the answer and the question to make sure that the answer deals directly with the question asked.

An essay question requires the test taker to compose his own answer, which may vary in length from a mere sentence or two to a lengthy discourse. And the content of the answer may vary from the recall of specific bits of information to a well-organized critical evaluation of a philosophical position.

The ideal answer should show that the learner (a) understands the question, (b) knows the relevant material, (c) can present the material in an organized manner, and (d) can present ideas clearly.

The general principles of test taking apply to taking essay tests. The learner should know the material thoroughly before the questions are read. Some students like to record on the back of the examination facts and formulas that have been memorized.

The first basic principle of taking an essay type examination is to read all the essay items, jotting down beside each question the points that occur. There are several reasons why this time will be well spent. First, by reading all the questions at the start there will be time to think over some of them, perhaps subconsciously, while answering others. Second, ideas which occurred to the learner at the start of an examination may be lost if they are not written down. The effort expended in answering one question in depth can block out ideas pertaining to another question. Third, the ideas written down can serve the learner as a beginning of an outline for his answers.

Pauk (1969) suggests a procedure for organizing answers before writing them. The learner should go through and place a checkmark alongside each major idea, then look over the major ideas and decide how to order them in his essay. The ideas should be numbered accordingly (1, 2, 3,...). To support each major idea, the remaining notes should be correspondingly designated (1a, 1b, 1c,...).

Using the outline suggested above, the student should begin by writing a direct answer to the question and devoting all subsequent

paragraphs to supporting, amplifying, and modifying every point made in the paragraph. This can be done by giving, where applicable, dates, names, examples, and exceptions, as well as by explicitly stating relationships, causes and effects. The answer should be made clear by well-chosen "trasitional" and "directional" words.

It is rare that the instructor will ask a question about which the learner has no knowledge. Since almost all instructors give partial credit on essay questions, it is worth the students time to marshal the fragments of his knowledge to give some sort of answer. If the learner runs short of time, then it is appropriate to outline an answer by noting the intended points of composition. Many teachers grade on the number of actual ideas or points made rather than the amount of verbage that surrounds any one point.

Sentence completion items are sentences in which one or more words, symbols, or numbers are missing. The learner must recall a suitable answer and complete the sentence. Because definite answers are required sentence completion items are used primarily to test for specific information. There are very few test-wise strategies which can help a student on this type of test if the facts are not known (Pauk, 1969).

There is never a penalty for guessing on recall-type items. The portion of the sentence completion item which is presented places restrictions on the kinds of answers that are logically permissible. For example, the item: "An important function of the human liver is _____.", requires an answer which identifies some important task the liver fulfills in the human body.

The learner should be aware of the grammer used to help him decide the correct answer. The word "an" immediately before the answer blank

indicates that the intended answer begins with a vowel sound. The use of "a" probably means that the intended answer begins with a consonant. Also the use of certain modifiers in the sentence may indicate the degree of generality desired in the answers.

Some test makers use two or more separate blanks to indicate that a multiple-word response is desired. Other test makers, however, offer no such clues; they use a single line even though a two or three word response is wanted.

Objective tests are most frequently composed of multiple choice, true-false, and matching items. There are some learners who do poorly on objective tests for various reasons, such as inaccurate reading of the questions, inability to detect subtleties, or simply because of a negative mental set, "I never know what the test maker wants".

Millman (1965) suggests some strategies for taking objective type tests. Often students find some ambiguity in some word in the test question and given an answer based on this. The learner should always choose the answer which the test maker intends. The question should not be overinterpreted.

Millman also suggests that the learner anticipate what the answer will be like; then look for it among the options. All of the alternatives should be read and considered. This procedure of suspended judgement is especially pertinent when dealing with multiple choice tests. If the anticipated answer is not among the options, then it should be promptly discarded and each option should be systematically evaluated for how well it answers the question.

When several options look good, or even if none look good, compare them with each other. If two options are highly similar, study them to find what makes them different. Options which are known to be incorrect should be eliminated as well as those which do not fit the "promise" or requirements of the question. Teacher-made tests which cover a limited number of facts and concepts may contain information in one question which will be helpful in answering some other question.

Some specific determiners such as "rarely" and "usually" which qualify the main statements in questions should be taken as serious clues. When a word is qualified by the word "always" is does not mean 99% of the time but 100%, and should be taken quite literally. In true-false tests the learner should make statements true only if they are true without exception.

8. MEMORIZING

The section on memory begins with a review of classical and popular mnemonics. Then follows a discussion of memory from the currently predominant information-processing view of short and long term memories.

Mnemonic Devices

In the days of ancient Greece and Rome, the art of memory was highly cultivated, especially by orators. There was a Roman textbook on "artificial memory (Yates, 1966). Since the advent of printing, the methods of rote memorizing have fallen from prominence.

A leading scholar on memory today (Norman, 1969) states that the ancient rules are still valid and that modern science has added little to the practical art of remembering things. For this reason it seems appropriate to include the basic principles and a few of the major techniques of mnemonics. This material is not generally found in psychology or education texts, but appears in unscholarly books and is practiced by stage entertainers and advertizers of memory-training methods. It is felt that a knowledge of these techniques may prove useful for certain special memory needs where reference to notes is not possible. An accurate memory can by useful.

One thing a good memory does not depend on is practice alone. Long ago, William James (1890), in one of his rare experiments, showed that mere experience in memorizing had no effects on improving the memory. The finding that memory is not a skill in the sense that weightlifting is, is well established (Norman, 1969). Blind practice is not effective, but practice after instruction is effective as shown by experiments by Woodrow (1927) in which he extended James's experiments.

It appears that the many systems of memory training have much in common, in addition to not relying on untutored practice. Norman (1969) compares searching the literature of mnemonics to reading the alchemists for their recipe for gunpowder. It involves establishing the relative contributions of powdered frog's tongues, sulphur, charcoal, and saltpeter.

All mnemonic devices seek to relate the material to be learned to some previously learned organizational scheme. The variety in systems is mostly in the particular scheme that is learned in advance and used to organize and store the new material. Everyone apparently has his own idiosyncratic means of doing this. A given person's system may be only partially understood by himself. Individual differences in the way people make associations and organize things to be learned has been the bane of experimental psychologists. These scientists have been partial to meaningless material in their study of memory. Subjects have an annoying tendency to attach meaning to nonsense syllables and to make bizarre connections between "unrelated" pairs of words.

In describing mnemonic devices, the intent is to illustrate some practical applications of principles of memory that have been known in some form for centuries, that are used with partial effectiveness and limited awareness by everyone, and that often have been treated as undesirable individual differences (experimental noise) by laboratory psychologists.

Before looking at some particular devices, a few general remarks are in order. It appears that there is no practical limit to human long term storage capacity. This conclusion is based upon the memory feats of trained practitioners and a review of memory literature. The extra burden placed on the memory by embellishing the material to be learned is not too demanding. Human memory capacity apparently expands with the number of associations previously learned. The richer one's store of details, dimensions, and images, the more opportunities that exist for relating the new to the old.

Another fundamental property of all methods is that the material is organized externally before attempting to relate it to a previously learned structure. This principle is common to almost all popular or scholarly discussions on memory.

The key problem addressed by memory systems is retrieval. Storage is not enough. A book may be in a library, but if not properly catalogued and shelved, its usefulness is limited. The guiding principle is that retrieval will depend upon the same strategy as storage. To continue the library analogy, a book shelved under the Dewey Decimal System is not as readily located when using the Library of Congress classification.

Method of key words. An example of a plan for memorizing ten unrelated words is given by Miller, Galanter, and Pribram (1960, p. 134-136). First, the following rhyme is easily memorized:

one is a bun,
two is a shoe,
three is a tree,
four is a door,
five is a hive,
six are sticks,
seven is heaven,
eight is a gate,
nine is a line, and
ten is a hen.

Then one forms a bizarre visual image between each word to be memorized and the key word in the list. For example, if the first word were "locomotive," then one could conjure up an image of a giant hot dog bun, with wheels, cab, and smokestack, merrily going down the tracks.

The method of key words has several virtues: it is easy to learn and use, the words can be retrieved in serial or random order, and the method has appeal to many children in the upper elementary or higher grades (personal observations).

Methods of rhyme or rhythm. Metrical devices are popular for connecting things into an ordered relation, for when the meter is broken, it is obvious a mistake has been made (Norman, 1969). The usefulness is limited to rules in order that are easily confused. Common examples are:

i before e
except after c

or

thirty days hath September,
April, June and November

Children are sometimes observed reciting the alphabet in a tuneful rhythmic manner. In addition to brevity of content, a disadvantage of the metrical method is that the whole must often be recited to recall a part.

The method of loci. This ancient and powerful method requires more strenuous preparation and effort, but it permits prodigious feats of memory. It is not suitable for children in any but the most abbreviated form. Senior high school students could master the basics. The method is described in detail by Yates (1966).

The purpose is to memorize long lists of words, things, or topics, where order may be important. The first step is to become intimately familiar with a spacious and varied building. Images that will trigger the items to be remembered are then associated, one by one, with various loci (parts or furnishings of the building). The building is then mentally toured associating items with loci, preserving the order of items. This process of touring is mentally rehearsed until well-established.

Loci should have certain properties. They should be well-known, well-ordered, numerous, and capable of being recalled from any point in either direction. Loci may be embellished with details of distance, lighting, or

other embellishments. A great advantage lies in the fact that the same set of loci that took so long to master, may be used for many different memory tasks at different times. Thus, in the long run the method is not as uneconomical as it would be if employed only once.

The image that the person creates to link the loci with the item to memorize should have strong affective or emotional properties. They should be, for example, strikingly beautiful, ugly, or comic. They might be unusual, bizarre, or even obscene. In any case, they should be active images, strong in impact.

Method of analytic substitution. Another method for learning long lists of words or numbers goes back seven hundred years (Norman, 1969). The principle, used in many popular and effective systems, is to change numbers into sounds, sounds into words, and words into sentences. This method of remembering dates or figures is effective after an initial investment in learning the consonant equivalents of numbers and in practicing the technique of translating. Most persons would find the method of limited usefulness (Weinland, 1957). However, it may be interesting to older children.

After learning the consonant equivalent of numbers, one supplies vowels to make words, and then makes sentences out of words. There is room for many imaginative variations to produce colorful phrases and sentences. A mental recital of the learned sentence provides easy cues to reconstructing the original number sequence.

Short-Term Store

A review of the contemporary information-processing approach to memory is provided by Howe (1970). The experimental evidence in support of various types of memory is reviewed by Howe (1970) and will not be detailed here. It will be assumed that memory is not a single process, for as Atkinson and Shiffrin (1968) state: Any single-process theory that seeks to explain the data of memory must, of necessity, be so complex that "single process" becomes a misnomer.

A simplified view will be adopted here. Two types of memory will be identified - short term and long term. These are sometimes spoken of as primary and secondary memory (James, 1890). A third type of memory is addressed in the literature, but will not be treated here because of limited educational application. That is visual short term memory. This involved the retention of images for about one-half a second. This is referred to as the sensory register by Atkinson and Shiffrin (1968).

There exists a short-term store which retains material for up to about one minute. This short term store differs from the sensory register in several important ways (Howe, 1970): (1) Material is auditory or acoustical, (2) material can be preserved by rehearsal, (3) even without rehearsal, materials can be retained for a number of seconds, (4) it is possible that all retained verbal material must pass through the short-term store, and (5) complex coding processes are involved.

Materials in short-term store seem to be retained on the basis of simple sound properties, rather than meaning. This may have

implications for school learning of verbal materials. The importance of correct pronunciation by both the teacher and student is of critical importance. Conrad (1962, 1964) showed that background noise caused errors in learning of a type where a similarly sounding letter was mistakenly remembered for the correct one. It is probable that a faulty pronunciation can cause permanent errors in word usage. Everyone is familiar with the comical misuse of words by characters ranging from Amos 'n Andy to Archie Bunker. It is a fair conjecture that a faulty association between sound and meaning can be prevented by the learner's hearing new words pronounced correctly and immediately articulating them himself. It may be that usage of the pronunciation key in a dictionary is more than a nicety, it may be a key learning skill. If this seems burdensome, one must consider the considerable effort needed to later relearn the correct sound-meaning associations after they have become part of permanent memory and have been used on many occasions.

There seems to be less individual differences in short-term store than in long-term. The former seems more automatic and does not involve the complex encoding that is required for permanent storage. The capacity of the short-term store is very limited. In a well-known paper, Miller (1956) indicated that the limit was about seven (plus or minus two) units of information that could be kept in focus at one time. The units could be numbers, words, or larger categories of information. There has been argument about individual differences, but Miller's guess is still regarded as being in the right neighborhood. Miller (1956) found that the capacity could appear larger if, for example, the subject learned a code word for seven pairs of words. He could then appear to have a capacity

of 14 items. This process of "chunking" can be developed as a powerful method of storing and will be treated more fully in the next section on long-term store.

Rehearsal seems to be a key mechanism for both retaining information for immediate use (a telephone number) and for allowing encoding into permanent memory. Unfortunately, authors on memory have almost nothing to say on the subject. They generally testify to its importance, however. Rehearsal seems to be silent, subvocal speech. It may be that this process changes visual information into verbal material for permanent storage. The way a subject rehearses can change the results of a memory experiment (Norman, 1969, p. 86). Brown (1958, 1959) saw rehearsal as a means of preventing decay of the memory trace. To him it was similar to new presentations of the material. Other theories of memory also stress the function of rehearsal in increasing the likelihood of storage in permanent memory. It appears that decay is caused by the absence of rehearsal. Whether the passage of time alone causes decay seems a moot question.

In summary, it seems important for the student to know the properties of short-term memory and its usefulness for both immediate recall and for allowing encoding into permanent storage. The principles applicable to holding information in short-term store are also applicable to furthering the long-term storage. These principles are discussed in the following section.

The major functions of the short-term store are (1) to hold a small amount of information for immediate use, (2) to allow translation from acoustical and visual to verbal form for permanent storage, (3) to act as a buffer in adjusting the differing rates of encountering and encoding stimuli, (4) to allow organization of new material according to previously learned structures.

Long-Term Store

The long-term memory has vast capacity, and organizational factors are of great importance as in any large information system such as a library or computer system. Individual differences are pronounced in variables that reflect efficiency in usage of this secondary memory. It is a premise of this report that individuals can benefit from instruction in principles of remembering and retrieving. It is felt that this has been a neglected area of the school curriculum. Organizational characteristics of memory are treated extensively by Mandler (1968), Tulving (1968), and by Howe (1970).

Primary organization (Tulving, 1968) refers to strategies of grouping and ordering that do not consider the meaning of the material. An example is the grouping of items in two's or three's in their order of presentation. It has long been known (Oberly, 1928) that such grouping increases the number of items recalled correctly. Subjects given lists of 10 digits to recall have been observed to voluntarily group them (Fraisse, 1945). Wickelgren (1964) found that maximal retention of digit sequences occurred when grouping was in units of three or four.

The more powerful methods of organization involve the semantic or phonetic content of the material and are called secondary organization by Tulving (1968). The most notable of the methods that involves the meaning of the material is what Miller (1956) called chunking.

A chunk is a unit of information, but the content of the unit may be as small as a single digit or as large as a word, or larger. According to Miller (1956), and to later research summarized by Howe (1970), the number of chunks that can be dealt with concurrently is limited, but the size of

chunks is not so limited. An example of chunking given by Miller (1956) is the learning of Morse code. At first each dot and dash is a separate unit, then sounds are organized into letters. After further experience the letters are organized into words and phrases. This greatly increases the length of the message that can be remembered, even if the number of units is fixed at about seven.

This process of processing larger and larger units, or chunks, is called recoding by Miller (1956). The process of recoding seems to be central to organizing memory. Miller (1956) further suggests that this is a largely automatic process, and that it occurs when people put material into their own words as an aid to retention.

Chunking and recoding make use of the attributes of the items as perceived by the learner. This is therefore a cognitive position rather than an associationist or behaviorist theoretical position. Deese (1968) points out the inadequacy of associationism as an explanation. Tulving (1968) also points out that demonstrated associations between items to be remembered calls for explanation rather than provides it. Howe (1970) comments that it is necessary to determine the nature of the associations. This seems especially necessary if students are to be instructed in methods of improving their memory. It also seems possible to a certain extent.

Categorization appears to be an ubiquitous organizational process. Bousfield (1953) had subjects learn a list of 60 animals, vegetables, names, and professions, all in random order. Upon recitation subjects tended to cluster their responses into the four categories. Other studies have shown the same phenomenon (Howe, 1970). The above categorization was obviously simple and planned by the experimentor. In real life situations

individuals would be expected to differ widely in their bases for categorizing. This would depend upon their unique personal set of stored concepts. Mandler (1968) presents several experiments which show that recall is more efficient with larger numbers of categories - until about seven are reached. An experiment by Tulving (1962) shows subjective organization. A list was presented in a different order each time, but on each recitation the subject repeated the words in the same order.

Sequencing items into a meaningful order contributes strongly to remembering. This has been demonstrated in a number of studies cited by Howe (1970, pp. 70-71) in which sets of words are used which vary in their approximation increases from a random jumble of words to an acceptable sentence, then the probability of recall increases accordingly. Placing items in an order that is meaningful to the learner is a promising avenue in instructional strategy. The order could be temporal or some other serial organization. Individual differences might be capitalized upon by training students in various methods of organization and then allowing them to use their preference in any learning task.

Although psychologists have concentrated their studies of memory upon the short term store, it is apparent that the probability of long term retention depends heavily on the individual's frame of reference and less on universal properties of the memory system. What is important is the interest, comprehensibility, and perceived importance of the material. It is well known that the amount a student learns is affected by his attitude toward the material.

Nian and Kay (1954) made a powerful observation about long-term memory. They observe that what an individual remembers is actually a kind of précis

of the original. A person perceives things under his own frame of reference and this influences later recall. He may recall his erroneous impressions or conclusions made at the time of an event as fact. While it is advantageous to put material into one's own words it is important to separate fact from opinion before the latter becomes a part of permanent memory.

The remainder of the section on memory reviews generally accepted principles found in many works on learning. No specific citations are attempted, as credit can rarely be properly accorded.

Since it is undeniable that comprehension aids long-term memory, a brief review of aids to maximizing comprehension is in order. The learner should habitually attempt to clarify any unclear words or concepts or relationships between concepts. He should interpret to himself in his own words the meanings of concepts and relationships. He should consider the source, purpose, and possible error or bias of the material being learned. He should become aware of the type of organization already present in the material (taxonomic, cause and effect, chronological, etc.). He should attempt to put into perspective both the material and his reasons for learning it. He should establish the detail needed in retrieving and plan accordingly.

To maximize interest in the material he should take time to relate it to what he already knows. The immediate and long-term benefits of remembering should be considered.

Spacing of effort is a principle that should be learned and practiced. Time should be allowed for rest periods and for review and rehearsal periods. Total study time should be budgeted into a number of shorter periods for maximum long-range retention. The effects of cramming for an exam should be known by the learner: the technique is effective for overnight retention, but not as effective as spaced study for more permanent remembering.

It is important to reproduce what is being learned. The learner should verbalize to himself, converse with others, write, always checking on his accuracy to insure correct future retrieval. He should reproduce items together that are to be retrieved together.

Interference should be minimized by proper planning of study activities: plan to avoid times of expected fatigue or drowsiness. Plan to minimize conflicts with more interesting activities. Plan to avoid known distractors - noises or persons. Between periods of intensive study, avoid material similar to that under study. Divide material into small logically coherent sections to minimize interference between various parts.

The learner should recognize the need for overlearning and practice the procedure as needed. He should reproduce material somewhat beyond the point of bare mastery in order to counteract the effects of future decay.

Retrieval is dependent upon the adequacy of storage. Hence, the emphasis in this section is on storing procedures. The learner should try to retrieve with the same strategy used in storage. Cues of category, context, temporal order should all be employed. It is not too far-fetched to recreate posture, activities, even smells for cues. Retrieval should be in a meaningful sequence.

To improve memory, the summary points are: do not plunge blindly at reading or reciting. Summarize the meaning and structure of the material. Relate what is to be learned to what is already known. Divide the material into small sets of logical subdivisions. Space study time. Recite and Rehearse. Check accuracy of reproduction.

9. ATTAINING CONCEPTS

The learning of concepts is essential to functioning in any human society. Concepts are fundamental to language, memory, and thinking. A concept may be defined (Johnson, 1972, p. 33) as an abstraction used for classification, communication, and problem solving--according to the standards of the culture. A concept is learned (formed, attained) when two or more objects or events can be grouped or classified together and set apart from others on the basis of common features or characteristics (Bourne, 1966, p. 1).

Class concepts are discrete subdivisions of things or events into qualitatively different categories, based upon one or more attributes. Use of class concepts involves a cognitive structure of subordinate and superordinate classes. Conjunctive concept classes are composed of things that meet two or more criteria simultaneously. Johnson (1972) provides the example of a licensed driver who must meet an age criterion and pass a test. The learner must identify relevant dimensions and ignore the irrelevant cues when he is forming or using a class concept. Disjunctive class concepts are less common and involve the meeting of several criteria. Relational class concepts involve a relation between two or more attributes of things. Relational and disjunctive classes are more difficult to learn than conjunctive classes.

Dimensional concepts does not involve the assignment of objects to abstract classes, but rather requires the placement of objects along abstract dimensions. Dimensions are continuous, while classes are discrete. Johnson (1972) notes that small children first use "big" and "little" as classes. They later expand the number of classes with modifiers, and finally come to use general terms of length and weight for the continuous dimension.

Explanatory concepts are higher order abstractions that state relations between concepts. These principles are dealt with under the section on problem solving.

Singular concepts refer to a cluster of memories, affects, or associations, gained directly or from others, pertaining to a single object. The richness of children's singular concepts increases with age and experience.

Concept attainment may be tested by means of classification, ordering, or verbal operations. Classifying may consist of having the learner identify objects as belonging to a given class or not belonging. At a higher level of responding, the learner may describe the relevant attributes of a class and the rules for combining them to define the class. Ordering may likewise be demonstrated by proper sequencing of objects or by stating the dimensions upon which objects are ordered. Various verbal operations may indicate the meaning of a concept. Extensional meaning is illustrated by pointing to or naming examples of a class. Intensional meaning is established by stating attributes of a concept. Other verbal operations include naming subordinate and superordinate classes, stating approximate synonyms, or using the concept word in a sentence.

To understand a concept it is essential that one recognize the dimensions or attributes that form its definition. Preliminary findings by Odum and Switsky (1972) suggest that a child will attend consistently to one dimension of a stimulus--color, shape, texture, position, for example--in preference to other dimensions. He will respond to what he sees in a ranked order of preference, forming an individual "hierarchy of salience," which can be experimentally determined. Odum, Switsky, and colleagues conjecture that:

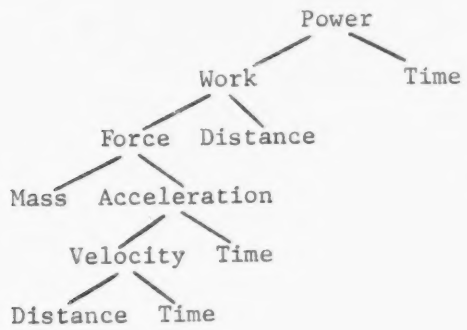
> Many of the gaps in individual performance that have been attributed to differences in race, intelligence, motivation, socioeconomic background, and other factors may prove as a result of current research to derive from individual tendencies to perceive certain dimensions of stimuli and not others, to conceptualize well or poorly depending on the sufficiency of the stimulus input. If this indeed proves to be the case, these studies will provide the foundation on which strategies for intervention can be built.

Earlier research on perceptual learning (DeRivera, 1959; Rasmussen and Archer, 1961; Gibson, 1963) indicates that individuals can achieve permanent benefits in handling new or confusing stimulus arrays from practice with the arrays. Judgment experiments requiring attending to several characteristics of the stimuli simultaneously caused transfer of concept attainment ability to another task. The readiness or transfer phenomenon appears somewhat similar to the notion of a learning set in problem solving. If apes can acquire a learning set it does not seem unreasonable to expect even more from humans. Learning to learn concepts is an area of promise that has not been explored.

Other abstract concepts are not easily defined by attributes, dimensions, or rules. They are described by associating verbal labels from some domain of discourse. It is almost impossible to disassociate concepts from the meanings of words, especially the more abstract words that are not infrequent in everyday life and abound in academic disciplines. Concepts like "fairness" that children use correctly in their play activities are in the category of those that are difficult to systematically define by attributes and rules.

One device for describing the knowledge of such concepts is illustrated by Johnson (1971). The technique is to try to arrange words in a hierarchical display. The example provided is that of a concept of power in physics.

To construct such a structure one begins by listing what concepts are



prerequisite to the given concept. These second level concepts are then broken down into their component concepts, and the process continues to form a hierarchical structure. Basic or primitive concepts are frequently noted at several levels. Such a method is not without difficulties. Individuals may not agree as to the composition of concepts. As is true of many postulated types of learning hierarchies, the successful use of a higher level concept may not depend upon mastery of a lower one. In fact, the teaching or learning of concepts may proceed more effectively in the downward direction in some instances. Thus the logic of determining prerequisite concepts may not reflect the optimal learning strategy in all cases. To illustrate from the example taken from physics, consider that a young learner may have a valid intuitive notion of what is meant by power, but be hard pressed to deal with acceleration.

The making of hierarchies of concepts may have some utility for the learner and may also provide a basis for testing attainment of many concepts. It would be expected that this is a skill appropriate for older learners--one that comes after success in making hierarchies of more concrete classes. Psychologists have done a great deal more study on concept attainment involving simple stimulus dimension, but far less has been learned about conceptual behavior that is dependent upon verbal labels and associations between them.

10. PROBLEM SOLVING

Speculation on the nature of the problem solving process goes back to antiquity. Discussions on the subject frequently cite John Dewey's (1910) five steps. These have been elaborated on, added to, and embellished in various ways by numerous writers. The present commentary and outline of skills draws upon many of these sources, directly or indirectly. More comprehensive reviews, additional perspectives, and fuller bibliographies can be obtained from Bourne and Dominowski (1972), Johnson (1972), and Gagné (1970).

Dewey's first step was the feeling of a difficulty or recognition of a problem. Most of the problems in life and at the higher levels of school learning do not come in the form of routine, neatly packaged exercises or drills. The more responsible and mature must be capable of detecting the existence of a problem without explicit directions. Rather than being totally oblivious to a problem situation; too often persons feel a vague negative affect or discomfort. One of the chief goals of the present investigation is to provide the learner with a repertory of behaviors to reduce the negative feelings and avoidance behaviors associated with problems. A set of systematic behaviors to handle problems in their varied forms can be learned. The learner should develop habits that reduce the aversive stimulation of threatening problems and replace it with implicit positive reinforcement of uncovering or clarifying a problem. That is, it should be an automatic, game-like response to uncover problems. Reinforcement by the teacher is too often for routine solution of teacher- or text-presented problems in complete form. This is remindful of the discovery approach, but

more emphasis is placed on discovering or clarifying problems than on solving them. This has been done in some of the inquiry-oriented curricula.

The building of confidence in problem solving ability is critical. A few basic and proven procedures can get the learner moving productively--just as Arthur Murray has been commercially successful by quickly providing a few basic steps to get the novice on the dance floor with immediate positive reinforcement.

The presentation of a problem is frequently in the form of a question. Usually the question needs to be evaluated, refined, discussed, and clarified in various ways before the learner rushes into the later steps of problem solving activity. Thus, after a problem is felt, the adequacy of the resulting statement of the problem must be evaluated. Is more information needed? Is some of the information superfluous or misleading? This process should be repeated periodically as one aims at a solution. Frequently the problem needs to be reformulated several times as more information accumulates and hypotheses are tested and rejected.

The elimination of distracting information makes some complex problems easier, and the addition of unnecessary material can complicate basically simple problems. The addition of superfluous material slowed solution time whether the added data appeared relevant or not (Campbell, 1968). The key factor, however, is not the extra time required in sorting out information. The danger is in starting out on a wrong approach. A false start is very hazardous and may lead to frustration, an inhibiting set, and even total abandonment.

After the problem has been clarified, one should decide if a standard solution is applicable. This may consist merely of looking up a topic in

an encyclopedia or applying the distance formula to a motion problem in high school algebra. An appropriate strategy is to consider if convergent or divergent activity is required. The learner should orient himself to either systematically searching for an existing solution or creating a new one.

The learner should determine the need for consulting another person. If it is appropriate and permissable to seek assistance from others, much time can be saved in finding a standard solution. The learner has then added a useful bit of knowledge to his store.

Content knowledge is important for success in solving problems. It has been demonstrated over the years that the same form of problem is easier when the words are familiar than when rare or nonsensical words are used (Wilkins, 1928; Brownell and Stretch, 1931; Tresselt, 1958; Johnson and Van Mondfrans, 1965). Background study in an area is an aid to solving problems in that area. The well-established positive relationship between vocabulary and general intelligence scores may depend in part on this beneficial effect of familiarity. At the least, a person is likely to perform better on verbal tasks if he has a rich vocabulary or has mastery of the nomenclature of the area of application. The debate on the relationship between language and thought is not continued in this report. The reader can imagine himself talking to someone with alien competencies such as a master automotive mechanic, and being at a great disadvantage in understanding the intricacies of a problem. It is a bit awkward to reason with an entirely spatial orientation or be confined to descriptive terms like "gadget" or "do-funny."

Establishing beforehand the criteria for a solution should be done routinely. Too often even adults do not think this through before plunging into a search for solutions. What is an Egyptologist? The learner should

decide if a dictionary definition is sufficient, or is there a need for a detailed account of the training and duties of a person with that title. What form should the solution be presented in? Verbal, notes, or a finished document with illustrations and references. These skills may seem obvious to persons with graduate education, but the independent learner needs to be aware of the appropriate options and not be limited to the habits of a particular teacher. Any teacher who has ever made a term paper assignment has had the question, "How many pages?" If the problem requires a numerical solution, then what is the appropriate unit of measure? Should an exact or approximate solution be given? Should one number be arrived at or should an appropriate range of values be the target? Students can miss a problem when they "really" knew how to do it because they failed to properly define the characteristics of the solution sought. It is discouraging to come so close and fail to get credit. Sometimes in the joy of solution the student will fail to translate the answer into appropriate form or units. Thus, it is important to take the extra effort to check the solution against the required form.

In characterizing the solution, it should be determined if the solution is to be a principle or a procedure. Is the solution something that will be applied to other problems? If a procedure, is it something to be practiced and perfected or only a one-time task?

Larger scale problems often call for a task analysis (see Section 1.) after the goals have been made definite. This analysis should clarify the needs for acquiring additional information or the learning of enabling skills or new concepts. If subtasks can be defined, then the pressure on the learner of an overwhelming problem can be reduced. Anxiety level can be reduced

to a productive level. The rudiments of management systems or displays such as PERT are not inappropriate for the middle or high school student.

The notion of a problem solving set appears useful in understanding and teaching the solving of problems. A set can be thought of as an intermediate status of the person between longer term motives and immediate activities. It is a condition of readiness to attend to certain types of stimuli or to make particular responses. A set may be illustrated by the expectation of seeing certain persons in certain places and the difficulty, or at least surprise, of seeing a person in an unexpected location. A set for the latter part of a sentence is established by reading the first part.

A problem solving set is most usually established by directions or a request by a teacher to do something. It seems imperative to make the establishment of a set more spontaneous and less dependent upon others. In individualized instruction or in daily life the person should not be dependent upon written, verbal, or computer-generated instructions. Social motives are important for bridging the gap between an individual's goals and the establishment of an enabling set. A person seldom thinks of the benefits to his future life of solving an everyday problem. It is more important that habits of seeking and attacking behavior be developed that will provide satisfaction from problem situations.

Problem solving activity frequently occurs in an interpersonal setting whether it be directions from another or evaluation by another. The learner needs to be aware of the opportunities to pick up unintentional or unspoken cues from others (Orne, 1962). Frequently another person evaluates the solution and he is not always objective. The criteria for a solution may be given partly by subtle cues of voice or posture. Many problems have

various solution possibilities. The learner is expected to take the opinions and biases of others into account and weigh them for probable accuracy. Other people can provide examples of skills or solution procedures, and it is useful to observe or question them judiciously.

When a person is faced with a familiar type problem he usually reinstates a set based upon his earlier experience whether the set is appropriate or not. This propensity can be changed by some different experiences immediately before the problem is presented. Brief exposure to a different approach can change the set on succeeding problems.

The usefulness of the set concept has been seen in psychology for several decades (Johnson, 1972). Sets can be either facilitative or inhibitory. The ability to shift sets appears to be a major determiner of problem solving success. It is often effective to periodically change emphasis between parts and whole.

Maintaining flexibility of set has features in common with productive thinking (Section 12.). For example, when the problem requires physical manipulation of objects, it may be helpful to let the mind wander about uncommon uses or combinations. Objects should be classified by function as well as by attributes. Flexibility of set can be maintained by periodically redefining the problem or solution characteristics. Transferring the problem from one mode to another can be valuable for new insights. Sketches, graphs, symbols of all types can be used. Shifting of mode may highlight unseen deficiencies. An omission that could be verbally glossed over may be conspicuous in a figure. Another way of varying frame of reference is to ask; What would an (engineer, architect, poet, salesman, etc.) do in this situation? Self-criticism must not be allowed to interfere with flexibility of set. There is a time for expansive imagination that must be allowed freedom. Of course, there are times

for routine applications of principles and procedures. There are times for cool logic and self-evaluation.

One of the main impressions gained from reviewing the literature for this entire report is the importance of appropriateness. The above case of logic versus imagination is an example in point. There are many others mentioned in these pages such as asking others for aid or working alone, or, applying a known rule as opposed to inventing a new rule. The learner must do more than merely react appropriately; he must act according to the knowledge that he has a choice, and should exercise discretion in every situation. He should not be a victim of circumstances or of poor habits. He should know principles of learning as an adjunct to using them effectively. He should not be dependent on outside control, whether it be chance or deliberate behavioral control.

Information seeking is an important aspect of solving many problems. One type of problem, the diagnostic or troubleshooting situation, has as its main feature the search for information. This type of problem can usually be solved in time by brute force, that is, looking at every possible source of trouble. The learner needs to learn strategies to make a more effective attempt at solution. Two variables were identified by Detambel and Stolurow (1957) as the amount of work to check a given component and the probability of success in finding the malfunction. The optimal sequence weighs each variable appropriately. Sometimes the amount of work or the probability of success is apparent, other cases require experience to determine empirically based estimates. Detambel and Stolurow found subjects changing back and forth but not usually adopting the optimal strategy and sticking with it.

The half-split strategy (also called binary search in computer applications) is applied when a large number of possibilities exist for the location of a defect. It can be applied, for example to locate an item in an alphabetical file. A mid-point is chosen; then whichever half has the defect (or item sought) is dichotomized again. The process is repeated until convergence occurs. Goldbeck, et al (1957) found this strategy readily teachable for simple systems, but slow in developing for complex applications. Dale (1959) found that subjects did not naturally use the half-split strategy where it is appropriate on an ordered system.

Strategies for gathering information can often be classified as safe or gambling (Neimark, 1967). The safe strategy, such as the half-split, is preferable even though gambling may prove lucky at times. The safe strategy provides the sought information in the smallest average number of moves. High correlations have been reported between children's adopting a safe strategy and their mental maturity (Neimark and Lewis, 1967; Rimaldi, et al, 1964).

Constraint seeking is another powerful strategy. It is illustrated in the game of twenty questions where the half-split is hardly applicable. The appropriate opening move is to ask a general question that will separate the unknown thing into classes such as living or dead, American or foreign, or hard or soft. Yes or no answers to appropriate questions lead to convergence. Constraint seeking is, expectedly, related to age in children (Mosher and Hornsby, 1966). There is no reason to reject the notion that these skills can be taught and developed earlier.

Representing and transforming the data involves a class of skills that are often taken for granted. They develop slowly over the years. Counting

is basic. Simple problems of allocating or dividing resources can be dealt with by representing the resource by beads or matches and apportioning them. This little task employs physical representation, an implicit model of the problem, and manipulating the model to achieve a solution. An analogy or isomorphism is made between the model and the real world. Operations of addition or deletion are preserved in the model. Counting on fingers is a more primitive physical analog device.

Symbols are frequently more convenient than representative objects in representing the data of a problem. It is usually important to get the facts of a problem down on paper. The data may be represented by verbal symbols: simple words, phrases, an outline or other arrangement. The memory load required in problem solving is usually more than is easily handled without representation. The verbal structure of a problem can be translated to other forms such as mathematical symbols. For example, one learns that "per" means "divided by" in mathematical problems, so that in finding miles per gallon the operation and the order of the factors are easily determined. Representing the individual pieces of data and classes of data by labels is often a help. Labels by attributes or functions are useful in organizing information. Labels are important in encoding information for the manipulations of problem solving and for decoding to translate results back to the real world.

The positive effects of labeling have been demonstrated experimentally and two results are described. Glucksberg and Danks (1968) presented a problem where a wire was too short to complete a circuit. A screwdriver was available. When it was labeled "screwdriver: handle, blade" the solution of using the blade as a conductor was made more often than when the

experimenters simply supplied the label "screwdriver." Maier and Burke (1967) found college students making many errors in the problem: A man bought a horse for $60 and sold it for $70. He then bought it back for $80 and sold it again for $90. How much did he make in the horse business? Errors were seldom made when the first transaction was labeled by the experimenter as involving a white horse and the second a black one.

Relationships can often be represented graphically when verbal forms would be awkward. Scale maps are useful when distance is important. Topological maps are useful when routes rather than distance is of primary interest. In this application only the relations between points is important. One can draw the subway lines of a city, for example, without concern for fidelity to scale or curvature. Other types of schematic drawings and diagrams can be employed. Representations of electrical circuits and musical scores are highly developed examples. Mastery of classification systems appropriate to the area takes advantage of the works of others. These include the periodic chart of the elements, the Linnean classification system, and even the Yellow Pages where occupations, products, and services are classified.

Symbolizing the target in an appropriate form may provide guidance toward a solution. In the proofs of mathematics it may be helpful to symbolize the conclusions and work backward toward the given hypothesis. Another important feature of symbolization is the provision for incorporating constraints. Boundaries or limits can be placed upon the manipulation of symbols to attain a target. Finally, the symbolic solution needs to be translated back to the original medium of the real world problem.

The making and testing of hypotheses is central to many problem solving techniques. The person frequently has one or more ideas for a solution based upon past experience. He may formulate hypotheses overtly, or implicitly try one of these known approaches. More complex hypotheses are followed through by means of a plan, which is described by Miller, Galanter, and Pribram (1960) as "any hierarchical process in the organism that can control the order in which a sequence of operations is to be performed." Plans may be complex enough to require written or symbolic representation. After a plan is executed, the hypothesis is tested by verifying the result against the solution criteria previously established. These steps may seem obvious to some readers, but they are not innate to the human. They must be learned. It is a premise of this report that deliberate teaching and testing on these and other learning skills can accelerate the haphazard process of learning how to learn.

Very young children can be told to stop and think and to think about what they are doing while they are doing it. They can also have tasks with steps that require reflection and recording to make the thinking habitual. Older learners can develop skills such as keeping records of hypotheses and varying one factor at a time when trying to locate a critical influence. Re-examining the problem characteristics as additional data accrues is another skill. Anticipating possible results is a skill that has increasingly complex applications as the learner matures. Judging the plausibility of alternative hypotheses is an associated skill.

Testing hypotheses is a class of skills. Testing may have to be done covertly in cases where they cannot be tried out. They may have to be tested symbolically or with models. Older learners can assign probabilities

to the success potential of hypotheses and vary these as the hypotheses undergo testing. Some problem solutions may be tried out in the real world, others may require judgements.

Can children be trained to solve problems? The scattered empirical evidence on this vital question is generally positive. The simple stop and think strategy is based on the belief that a premature attempt at solution may interfere with cognitive structuring and planning. Success was noted with this little advice by Cohen (1954), Ray (1957), and Duncan (1963). Asking questions rather than passively sitting in class is recognized as an aid to forming problem solving habits. Questions are information seeking strategies and these preparatory activities are often overlooked (Johnson, 1972). Inquiry training (Suchman, 1964) arranged for freedom to ask questions about a physics film and for prompt answers. Tapes were analyzed and played back for the benefit of the student in learning the consequences of various strategies for data gathering. These students asked more and better questions than those in a control group. Questions of the experimental students did not depend upon the teacher to do so much of the thinking.

The child models after prestigious elders. This result from social learning experiments on aggressive and moral behavior is also found in information seeking (Rosenthal, et al, 1970). Different groups of disadvantaged sixth graders were exposed to sets of pictures. The adult model in each group asked questions about the pictured objects that related to function, value, attributes, or relationships between objects. Each group of children demonstrated the same emphasis on other pictures that was characteristic of their group leader. This experiment shows the influence

of parents and teachers in slanting a child's information seeking. Success in teaching principles for solution has been demonstrated by Corman (1957) and Gagné and Smith (1962), among others.

The developmental sequence postulated by Piaget has been successfully challenged. Anderson (1965) taught young children complex problem solving skills. First grade children were given abstract problems involving concepts and principles. One group was taught the skill of varying one factor in succession while holding others constant. Their performance on transfer tasks was better than a control group. The students were bright and had been trained throughout the year, but they performed at a level of fourteen years on the Piaget developmental scheme of cognitive development. Training can overcome proposed requirements of age and accumulated experience. Stern (1967) was able to teach a simple problem solving strategy to third-graders in six lessons. Keislar and Stern (1970) successfully taught two problem solving strategies to very bright second and third graders. The more superior children profited most from the complex hypothesis testing strategy. Those of lesser ability gained most from the simpler gambling strategy.

It is difficult to generalize about the nature of problem solving activity or about the effects of training. There are so many variables such as the type of problem or the mode: verbal, spatial, or behavioral. The general conclusion is that training can be effective within classes of problem types.

11. REASONING

Deductive reasoning is concerned with applying the firm principles of logic to problems in determining valid inferences. In terms of the distinction of Guilford (1967) between divergent and convergent thinking, deductive reasoning is an exemplar of the convergent process. Some persons reason through logical problems well without training. Most people can benefit from instruction. Classically, the logic of Aristotle was studied in a stylized, verbal manner. Courses in philosophy called logic often concentrated on the form rather than on applications. In the past few decades, the study of logic has become more accessible and understandable due to the appearance of symbolic and diagramatic devices to replace much of the stilted verbage of formal logic. Truth tables, Venn diagrams, and other innovations have made logical reasoning both more teachable and more learnable.

Reasoning is viewed as problem solving where logic is applicable. This is different from other varieties of problem solving such as trial-and-error or productive thinking. Of course, many situations demand a combination of approaches, as when one tests the logical validity of an imaginative solution. Training in the methods of translating reasoning problems into logical form - to which formal rules can be applied - changes problem solving activity from the more general to the specific task of applying logic.

One of the major hurdles for those uninitiated in logic is to fully accept the fact that logic is concerned with the form of an argument or inference and not with the content. The conventions of logic are not those of everyday language usage. Consider the implication, "If the moon is made of green cheese, then it will rain tomorrow." If asked to state the truth

value of this statement, the response of a person untrained in logic would be unpredictable. He might incorrectly say false by inappropriately challenging the premise (which is obviously false). He might be incorrect in saying false because of the uncertainty of the truth of the conclusion about tomorrow being a rainy day. He might even be correct in stating that the statement is true, or valied in a logical sense because a false antecedent makes any implication true, regardless of the truth or falsity of the consequent. Not many learners in the intermediate grades would be expected to discern for themselves that an implication (a statement that can be put in if-then form) has associated with it three truth values. For most learners, separating the truth values of the component statements in an argument from the validity of the form of the argument is a skill that does not occur naturally, but it can be learned with training.

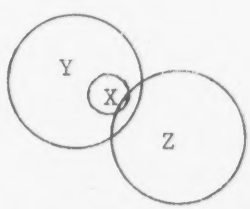
Logic is certainly content-free in the sense that the argument does not rest on the actual state of affairs in the real world, but depends upon the form, which can be changed from words to symbols or diagrams. Consider an argument that is to be evaluated as valid or invalid reasoning:

Some members are absent.
All the Robinsons are members.
Therefore, some Robinson is absent.

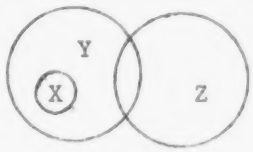
This can be represented as:

Some Y is Z.
All X is Y.
Therefore, some X is Z.

This situation can be represented with Euler circles as:



The figure on the preceding page shows the first premise satisfied by having at least part of Y overlapping with Z. The second premise is satisfied by having the entire X circle within Y. The conclusion is accurately represented by having part of X fall in Z. However, the figures could be drawn so that X and Z do not overlap.



In the above figure, the premises are still satisfied, but the conclusion is now false. An important skill has been illustrated: an argument is valid because the conclusion must follow from the premises, not because it can be made to be true. Put another way, an argument is invalid if only one counterexample can be shown.

At this point, after illustrating a few of the skills of logic, the question of appropriateness for the curriculum arises. Followers of Jean Piaget might argue that the abstract reasoning is inappropriate for children below a certain age. However, the formal properties of deductive logic appear to lend themselves to concrete operations with definite procedural steps that even younger children can learn the rudiments of. Instruction would be limited at first to visual and physical representations of simple reasoning processes such as selections by eliminating all but one alternative. Over the years, through high school, more of the mechanics of reasoning could be introduced.

Another hurdle to effective logical reasoning is encountered when the content is distasteful to a person because of conflicts with his moral or political values. A definite skill is to separate one's values from the rules of inference. A young child, especially, has the tendency to reject

a statement on irrational grounds if it is displeasing. There is no conflict between logic and belief. A mature person is able to separate an examination of an argument for validity from the content of the sentences making up the argument. If another person's conclusion is unacceptable, one looks to the validity of the argument form. If that is acceptable, he may then challenge the premises. One does not blindly attack the conclusion.

The effect of emotional content and subjective belief on reasoning has been the subject of a number of experiments. Janis and Frick (1943) presented subjects with 16 syllogisms in prose paragraph form with instructions to state whether each argument was sound or unsound. It was concluded that the subjects' biases made them tend to judge a conclusion valid when they agreed with it and invalid when they did not. Lefford (1946) gave graduate students syllogisms to judge for validity. It was found that those arguments that dealt with emotionally laden content were more often misjudged than arguments similar in form but dealing with bland material.

More recent workers have further pursued the biases in judging arguments. Parrott (1967) found that bias extended to the premises of Lefford's syllogisms. His subjects rated the emotional ones false significantly more times. A number of studies have studied the interaction of bias with reasoning. College students today do not know the classical meanings of contrary or contradiction. They were shown to be accepting of inconsistencies on the grounds of open-mindedness and democracy (Luchins and Luchins, 1965). Encouragement was shown by Feather (1964) wherein those who scored highest on a reasoning test with non-controversial materials were best able to discount their own biases when evaluating material of a controversial nature.

It is to anyone's advantage to reason unemotionally in many circumstances, and training in deductive logic will be helpful.

The effective learner and participant in life needs a variety of skills. He needs to be able to select among these learning skills to apply the appropriate class of skills. There is a place for the aesthetic to take precedence over the logical, but the effective person makes the choice of criteria himself and does not simply respond to the products of others. He knows when to adopt a free, uninhibited, creative role or to be coldly critical of his own work or that of others.

Logitians and debaters are familiar with types of fallacious argument. Psychologists have looked at these with the hope of explaining. One of the most notorious logical errors is that of the undistributed middle term:

All X is Z.
All Y is Z.
Therefore, all X is Y.

A psychological hypothesis was offered for this error to which intelligent adults are susceptible. Woodworth and Sells (1935) suggested that the person untrained in logic seizes on nonlogical verbal cues. The word "all" connotes a universal set that increases acceptance of the conclusion where "all" appears again in it. This was called the atmosphere effect, and applies to other instances such as the word "some" in premises making conclusion with the same modifier more palatable. Woodworth and Sells had supplementary hypotheses that a negative premise creates a negative atmosphere, even when the other premise is positive, and a particular premise creates a particular atmosphere, even when the other premise is universal. These hypotheses have stood the tests of confirmatory experiments (Sells, 1936; Morgan and Morton, 1944).

Another common error, sometimes considered a special case of the atmosphere effect, is the error of invalid conversion. This is illustrated by concluding that all X is Y from the given statement that all Y is X. (Even a younger learner with a little experience with Euler circles would not be expected to fall for this one.)

Separate training procedures for each type of error were set up by Simpson and Johnson (1966). Separate lists of syllogisms were constructed for atmosphere and for conversion errors. The two scales were fairly reliable and correlated negligibly, giving support for distinctiveness of the two concepts of error. Three groups of college students received training for the atmosphere effect, the conversion effect, and general training, respectively. Atmosphere errors were reduced by anti-atmosphere training, but the results were not so specific for conversion training. Nevertheless, general training had a measurable effect.

A fair amount of theoretical and laboratory work has been done on the dynamics of logical reasoning in children. As an example, the three-term series problem, or linear syllogism, involves only the relationship of transitivity of an order relation:

John is taller than Mary.
Mary is taller than David.
Is John taller than David?

Elaborate investigation and hypotheses have been made. DeSoto, London, and Handel (1965) dealt experimentally with spatial relations in cognitive space as explainers of solving linear syllogisms. A grammatical-spatial correspondence was postulated by Huttenlocher (1968). Clark (1969) applied principles from linguistic theory to the same type of little problems: primacy of functional relations, lexical marking, and congruence. The

approaches are mentioned for the purpose of illustrating the sophistication of contemporary effort on simple reasoning problems.

Can reasoning be learned? The evidence is that it can. The evidence is even more abundant that otherwise intelligent, educated adults are highly prone to fallacies in what they read. Reasoning requires the acquisition of ordinary and specialized concepts and the understanding of general language and special logical usages. Other subjects make the same requirements, but logic is so imbedded in and dependent upon the everyday language that there is much room for interference and much need for careful distinction between colloquial and formal usages. For example, "some" in logic means one, or several, or all of a set of things. The word generally implies less than all in ordinary English, especially if it is given special emphasis. Other examples are the uses of the word "or" to mean exclusion (one, but not both) or inclusion (one or the other, or both). New terminology and processes must be learned, for example, mapping statements into diagrams or truth tables. Johnson (1972) states:

> Such training is effective even in small amounts. It is not surprising that a college course in logic improves skill in handling logic problems, but average young men have acquired some facility in the calculus of propositions in only two hours of instruction (Moore and Anderson, 1954). A game played with logic cubes is said to change the drudgery of learning the calculus of propositions into an enjoyable pasttime, even for school children (Allen, 1965). Special instructions with diagrams and examples helped a group of adults to reach a high degree of accuracy in syllogistic reasoning in a short time and to demonstrate that the distorting effects of bias can be minimized (Henle and Michael, 1956). In Hunter's (1957) study of three-term series problems, an improvement appeared between the first and last halves of a set of 16 problems. Such improvement would not occur, of course, if formal reasoning were a routine performance that everyone practiced daily. Nevertheless, some people do learn such skills by themselves, and some make better use of what they have been formally taught than others. Hence, when intelligent

> adults who have not studied logic are compared on reasoning tests with those who have, the averages differ as expected, but there is considerable overlap between the groups (Morgan and Morgan, 1953).

Inductive reasoning is concerned with going from particular instances to general conclusions. It is not part of the ancient heritage of formal deductive that has been developed into the symbolic logic of the twentieth century. Induction reasoning shares many of the characteristics listed in the preceding section on attaining concepts. Classifying and ordering objects and events is a critical skill. Hypotheses are made and tested on differing combinations of conditions. Reasoning is usually on an open system where alternatives are large in number if not actually infinite. Techniques such as eliminating alternatives to determine the correct conclusions are frequently inappropriate.

There is little evidence for inductive reasoning having been treated experimentally outside of the concept formation experiments. If one takes a very broad view of induction, he may see it as a pervasive activity of life for humans and animals alike. For example, psychologists have treated the unconscious assignment of probabilities to consequences of behavior. Learning can be approached from the probabilities route. Every organism can be seen from this viewpoint, to be in a continual process of setting and adjusting the probabilities associated with behavioral options. The probablistic functionalism of Egon Brunswick is an elegant and influential creation. If we accept some of these notions, can the automatic process of setting implicit probabilities be improved upon by instruction? This question appears inadequately explored by educators or psychologists. It is interesting to speculate on the effects of training in elementary probability and statistical inference as applied to everyday activities rather

than laboratory or sampling experiments.

Inductive reasoning moves away from the traditional two-valued logic where a statement is either true or false and becomes increasingly like inferential statistics where the truth of a statement is accepted with less than 100% confidence. McGuire (1960) asked people to rate the probability of premises and conclusions in an experiment in deductive logic. He also asked them to rate the desirabilities of each in an effort to study the interaction between the two sets of probabilities. High school and college students were found to be somewhat logical even on controversial issues. There was some influence of desires on belief, or belief on desires; it is not possible to tell the direction.

One conclusion that stands out over the years in research in all types of reasoning, is the influence of negative information. When one is learning concepts or reasoning inductively, problems are encountered when negative instances are encountered or negative statements are supplied. Negation may be grammatically or logically a simple transformation, but psychologically the effects are complex and not readily predictable. Other superficially appearing opposites are not opposites psychologically. Notably, punishment does not have an effect opposite and equal effect to reward.

No suggestion is made in the present report that classical logic be instituted into the schools. Neither is it recommended that a faddish crash program in thinking be created. Examples have been seen in recent years of programs with questionable effectiveness that have been constructed by well-intentioned scholars in certain academic fields.

A course in reasoning can be made effective by drawing on the research that is touched upon in this and other sections. The difference is that there now exists a theoretical and empirical foundation that promises more

success than some earlier efforts in other areas. The skills lists and reviews of this report are only a beginning. They can be expanded and refined. But they do show that there is hope for systematic, behaviorally oriented instruction in learning itself.

12. PRODUCTIVE THINKING

Many of the activities called learning have definite goals which can be judged by routine assessment. Some exceptions to this are problems requiring original solutions. The current section deals more extensively with what Guilford (1967) calls divergent thinking. Success is judged on a continuous dimension (Johnson, 1972) of appropriateness or originality rather than on a right-or-wrong basis. The present report assumes that the complete learner must go beyond the mere mastery of traditional content and skills and be capable of effectively dealing with challenges of imaginative thinking. It is further believed that creativeness can be encouraged and to some extent even taught. The previous section concerned the cold analytical thought of the logician. Here, the emphasis is on stimulating that little bit of part-time genius that resides in everyone. The great minds of history are not renowned for feats of memory, cleverness or errorless performance. They are known for creativeness. They were not always productive, but spent much of their time elaborating on the ideas of themselves and others. They even made occasional mistakes in judgement.

Productive or creative thinking is regarded as a class of learning skills that supplements all the others. It makes the difference between mechanical, systematic accomplishment and the more unpredictable but highly valuable human intellectual accomplishments. Psychological knowledge is not as secure in this area as in some of the others. Nevertheless, a few insights are gained from the limited research on the conditions and processes of productive thinking. These will now be briefly reviewed.

Biographical evidence on the workings of great minds (Ghiselin, 1952; Koestler, 1964) is reviewed by Johnson (1972) from the point of view of a psychologist. This evidence is of an introspective nature and offers many hypotheses. Some of these are subject to scrutiny by the psychologist and some are of doubtful value. One of the main features of the biographies is the frequency with which great thinkers compare their own thought processes to those of other great thinkers. They often see the same patterns. This leads to the hope that something can be transmitted to others that, while not making everyone a genius, may help with more imaginative problem solving. The average duffer benefits from the lessons and books of golf professionals, even though his improvement may be only in breaking ninety.

One of the characteristics of a productive learner is sensitivity to problems. This is exhibited in finding problems or needs and asking stimulating questions of oneself or of others. The creative person is not always satisfied with the existing solution or order of things. Instead of accepting the conventional wisdom, he invokes new perspectives. There is a place in school learning for encouragement and training of productive thinking.

Several studies have attempted to characterize the creative person. MacKinnon (1962) found highly creative architects to be high in self-concept. A feeling of self worth seems to contribute to quality production. One of the major impressions from reviewing the literature is that one must not let negative feelings about the worth of one's products interfere with the production of those products. Self-criticism should come later, after a productive period. Many persons have experienced the phenomenon of being "hung up" in writing a report or essay. If one is overly critical of each sentence, he doesn't end up with many sentences. Editing and enrichment

should come later. Self worth is seen as basic to a feeling of confidence in one's products, and confidence is required for fluent production.

The study of architects showed that in the sample of 40 men, creativity was correlated with femininity. This was interpreted to indicate that creativity is associated with an openness of intellect and emotion, and a freedom to range widely in perspective and interests. A creative person is not inhibited by stereotyped roles of the culture. A criticism of the study is that creative architects are successful and hence self-confident. Even though evidence cannot be systematically adduced, it is an assumption of this project that feelings of self worthiness encourage creative learning --or learning of any type. Of course, there is a mutual relationship: nothing succeeds like success. It does seem particularly important to provide the learner with what are seen as aids to productivity and, hopefully, these skills will supplement encouragement from the teacher and feed the feelings of self worth in the learner.

There is sometimes expressed a notion that creative persons are somehow less mentally healthy than others. There is no general support for this and no reason to even suspect that any creativity training might be harmful. Creative writers were rated high on desirable personality factors by psychologists (Barron, 1965). Studies by Cattell and Drevdahl (1955, 1958) revealed no tendency toward psychopathy in successful writers, artists, scientists, teachers, or administrators.

Tests of creativity or divergent production have been developed and used. Among the more prominent are those emerging from the monumental efforts of J. P. Guildord (1967) and associates. The titles give some indication of the approach. Plot Titles require the subject to give title to a story plot, and this test loaded high on an originality factor. Quick

Responses gave high scores for uncommonness of word associations. Figure Concepts required finding common qualities in sets of drawings. Unusual Uses gave high scores for uncommon uses of familiar objects. Other tests required remote associations between pairs of words or stating consequences of unlikely events. Other tests are Mednicls's (1962) Remote Associates Test and the Torrence Tests of Creative Ability (Torrence, 1965). The latter have been most widely used in education. Titles include Asking Questions, Guessing Causes, Guessing Consequences, Product Improvement, Unusual Uses, Picture Construction, and Figure Completion. Wallach and Kogan (1965) developed individually administered, game-like creativity tests for children. They showed less evidence for a similarity of creativity with general intelligence than found with other approaches. The issue is unclear at the present time. It is uncertain whether creativity is an aspect of intelligence as measured by the conventional means or something in addition to it. The practical question of whether creative production can be taught and measured is more important to the present project than theoretical issues relating to intelligence. If production can be improved by training, it matters little whether what is being developed by the learner is called intelligence or productive thinking, or whatever.

Teachers have frequently been accused of disliking creative students. Getzels and Jackson (1962) reported teachers liking to work with high I.Q.'s but disliking to work with high creatives who were lower in I.Q. Torrence (1967) reported similar results. Apparently, some educational effort needs directing at teachers regarding the creative child, especially the one that is not particularly bright otherwise.

It appears that a rather indirect route is required, at this stage of knowledge, to gleam the determiners of creativity. Already examined have

been the historical and psychometric approaches. Another indirect method is to examine the personality correlates of creativity. Creativity scores of 100 military officers were corrected for differences in intelligence and the following traits were reported (Barron, 1957):

> Disposition toward integration of diverse stimuli.
> Energy, fluent output, involvement.
> Personal dominance and self-assertion.
> Responsiveness to impulses and emotion.
> General effectiveness of performance.
> Expressed femininity of interests.

Wallach and Kogan (1965) found distinct differences in the observed social personalities and classroom behaviors of elementary girls according to which of four groups they were in: high or low in intelligence or in creativity. The four-way classification was possible because this was one instance, as cited earlier, where the two variables were essentially uncorrelated. Boys did not show clear differences. These and other studies (Getzels and Jackson, 1962; Torrence, 1962, 1967) report that the high creative child is at a disadvantage when it comes to being liked by the teacher. Teachers like bright children that are not too creative (i.e., disruptive, in the eyes of the teacher).

Of central importance is tapping the creativity potential of the duller child, the underachiever, or the disadvantaged. The potential for improving the educational performance and general welfare of many children is enormous. Productive or creative activity is seen as a class of learning skills that offers a means of success in one area that can be transferred to other learning skills. Motivation comes from success. Success generates successes in other areas. The Learning Skills approach, as outlined in this paper, offers an avenue that can be entered by any child at some point suitable to his abilities. This avenue can make his schooling more productive and happier.

The mental set of a person in preparing for creative learning is important as illustrated in two experiments. Hyman (1961) had two groups of engineers study previous efforts at developing a box-recognition procedure for an automated warehouse. The group that was instructed to look for the merits in previous attempts at solution performed better in their own later attempt at solution than the group that received instructions to catalogue the faults of earlier attempts. Interestingly, there was a transfer effect to a second problem. Those receiving instructions for a positive appraisal made better solutions to an unrelated problem.

The other experiment (Torrence, 1964) reached a similar conclusion about the benefits of a positive set as induced by instruction. Psychology students who had earlier been instructed to read articles imaginatively were more original in their own hypotheses and ideas than those who had been instructed earlier in the course to read critically.

A major influence on creativity research was Osborn's (1953) book on brainstorming. The technique has two main features: the avoidance of criticism during production improves productivity, and productivity is enhanced in groups that feed on each other's ideas. Evidence for the social influence on productivity does not support the benefits of group over individual efforts (Johnson, 1972).

The other aspect of brainstorming--reserving criticism during the generation of ideas--has considerable support (Meadow and Parnes, 1959; Parnes and Meadow, 1960; Lindgren and Lindgren, 1965; Lindgren, 1967). The emphasis on quantity over quality does not prevent high quality products. It limits barriers that impede the free flow of potential ideas. Judging and selecting can be done later, by the learner himself or with others.

Training in word associations has been the object of a series of experiments by Maltzman, Simon, Ruskin, and Licht (1960). The basis is that principles of operant conditioning can be employed to enhance original thinking, which is viewed as an infrequent behavior whose frequency can be increased. Attempts at replications and criticisms have been forthcoming. The conclusion is that the technique is promising as a first step toward classroom application.

Training for the role of original thinker was undertaken by Levy (1968). College students were instructed to respond in a word association test as a certain other person would. Verbal reinforcement was given to uncommon responses. A list of the other person's responses was given as a guide to their personality. Several groups were given combinations of these treatments. All were effective to some degree in stimulating original responses.

An alternative strategy suggested by Johnson (1972) requires that attempts at creative solutions not be doggedly pursued, but should alternate with periods of incubation. Evidence from the reports of eminent persons led to this strategy. Time should allow for daydreaming or ruminating about the problem at hand or about some apparently unrelated topic. Many training programs for engineers and managers (Allen, 1962; Arnold, 1962; Gordon, 1961; Lincoln, 1962) offer some promise for adaptation to the classroom.

There seems to be an implicit assumption of educators that children should master the ideas of their elders before being allowed to develop their own. It is a thesis of the present report that this assumption is open to serious question. Again, reference is made to the large proportion of students who are below expectations in terms of ability or background. These students can be "reached" or motivated more readily by teaching and encouraging

them to develop and use their creative abilities, not only in art or music, but in word use and thinking.

Successful classroom training in fifth and sixth grades was demonstrated by Crtuchfield (1966). Large chunk rather than small step programming was used to stimulate thinking about complex ideas. Reinforcement was directed to production of relevant ideas rather than right answers. The program focused on a coherent, systematic attack on concrete problems, After several weeks experimentals were definitely superior to controls. A longer program involving active teacher participation was even more successful (Olton and Crutchfield, 1969). Other programs have shown promise for learning to be creative (Davis, et al., 1969; Reese and Parnes, 1970). Consistently, the importance of a favorable classroom climate and teacher encouragement are shown.

In perspective, there are three stages to the creative process. Preparation is illustrated by the discussion earlier in this section of establishing a mental set. Production has been treated above. Judgement, the final stage, is now briefly discussed. The creative problem solver not only must produce, he must select the best from among his products. This is especially true if he has mastered the suggested technique of producing in quantity while reserving quality judgements until later.

Efforts to train for judgemental skills have been made by several workers, notably Donald Johnson and his associates at Michigan State University. The thinker should not be disturbed by the different requirements of the free, imaginative production stage and the cool, deliberate judgemental phase that follows. These come at different times and are non-competitive with each other. The different mood or set requirements

make it important that the learner understand the overall strategy of having separate phases.

Improvement in one phase may improve the others. Johnson and Zerbolio (1964) found that producing Plot Titles improved judgements. It was concluded that practice in producing titles clarified the criteria. Johnson, Parrott, and Stratton (1968) trained subjects by having them study rating scales devised by expert judges, by having them make judgements with feedback of correct answers and explanations, and by having them practice creating superior and inferior solutions. The training was judged successful. Stratton, Parrott, and Johnson (1970) found transfer of judgement skills acquired in training to other problems. The most interesting experiment in the series (Stratton and Brown, 1972) found that training in both production and judgement was effective, each in its own way. In writing Plot Titles production training increased the number of titles, while judgement training increased the mean quality rating of the titles. One could not ask for more satisfying results.

LEARNING SKILLS

SELF MANAGING

ANALYZING THE TASK
SETTING PERFORMANCE GOALS
SCHEDULING
ATTENDING
SELF MONITORING
MODELING OTHERS

LOCATING INFORMATION

USING A LIBRARY
USING LOCAL, STATE, AND NATIONAL RESOURCES
USING KEY WORDS
DETERMINING APPROPRIATE SOURCES

PERCEIVING WRITTEN ORGANIZATION

RECOGNIZING GENERAL PATTERNS OF WRITING
RECOGNIZING PATTERNS OF SUBJECT AREA WRITING

READING WITH FLEXABILITY

SKIMMING
SCANNING
SURVEYING
ADJUSTING RATE TO PURPOSE
ADJUSTING RATE TO DIFFICULTY

PRODUCING ORGANIZATION

NOTETAKING
OUTLINING
SUMMARIZING

LEARNING WITH OTHERS

CONTRIBUTING IN GROUPS
LISTENING IN GROUPS
PERCEIVING A ROLE IN A GROUP
DISCUSSING IN GROUPS
BRAINSTORMING IN GROUPS
TUTORING

DEMONSTRATING LEARNING ON TESTS

STUDYING
SCHEDULING
READING DIRECTIONS AND QUESTIONS CAREFULLY
USING GOOD REASONING TECHNIQUES
INTERPRETING ESSAY QUESTIONS
INTERPRETING SENTENCE COMPLETION ITEMS
INTERPRETING OBJECTIVE TEST ITEMS

MEMORIZING

EMPLOYING MNEMONIC DEVICES
USING SHORT TERM STORE
USING LONG TERM STORE

ATTAINING CONCEPTS

CATEGORIZING OBJECTS OR EVENTS
DESCRIBING A CLASS VERBALLY
DEFINING A CLASS FORMALLY
ORDERING OBJECTS OR EVENTS
DETERMINING MEANING

PROBLEM SOLVING

DETERMINING THE PROBLEM CHARACTERISTICS
ESTABLISHING A PROBLEM SOLVING SET
MAINTAINING FLEXABILITY OF SET
SEEKING INFORMATION
USING SYMBOLS
MAKING AND TESTING HYPOTHESIS

REASONING

REASONING DEDUCTIVELY
REASONING INDUCTIVELY
REASONING BY ANALOGY

PRODUCTIVE THINKING

MAKING PREPARATION
PRODUCING
EVALUATING THE PRODUCT

1. SELF MANAGING

1.1 Setting Performance Goals

- 1.1.01 Analyzing the task
- 1.1.02 Setting terminal objectives
- 1.1.03 Setting intermediate objectives
- 1.1.04 Evaluating objectives for difficulty
- 1.1.05 Evaluating objectives for specificity

1.2 Self Monitoring

- 1.2.01 Scheduling
  - 1.2.01.1 Planning task/time schedule
    - 1.2.01.1.1 Listing tasks to be accomplished
    - 1.2.01.1.2 Ordering tasks according to importance
    - 1.2.01.1.3 Placing fixed times on schedule (eating, sleeping, etc.)
    - 1.2.01.1.4 Filling in proposed work times
    - 1.2.01.1.5 Planning breaks and recreation as reinforcers for completed work
  - 1.2.01.2 Developing self reinforcement schedule
  - 1.2.01.3 Evaluating and revising schedule periodically
- 1.2.02 Attending
  - 1.2.02.1 Identifying distractions
  - 1.2.02.2 Minimizing distractions
  - 1.2.02.3 Increasing on-task attention

1.2.03 Rewarding desirable behaviors

1.2.03.1 Observing likes and dislikes

1.2.03.2 Identifying a range of reinforcing events

1.2.04 Extinguishing undesirable behaviors

1.2.04.1 Identifying behavior to be changed

1.2.04.2 Recording and charting frequency of behavior

1.2.04.3 Identifying and removing reinforcers of inappropriate behavior

1.2.04.4 Substituting appropriate behavior

1.2.04.5 Recording until charts show behavior extinguished

1.2.05 Identifying and adapting to existing behavior management systems

1.2.05.1 Identifying the rules which are operating

1.2.05.2 Identifying contingencies

1.2.05.3 Identifying the reinforcing agent

1.2.05.4 Identifying systems in effect such as token systems

1.2.06 Identifying behavioral choices and consequences

1.2.06.1 Identifying alternative actions

1.2.06.2 Predicting outcomes

1.2.06.3 Assigning probabilities to actions

1.2.07 Identifying modeling behavior

1.2.07.1 Choosing associates with desirable abilities and behaviors

1.2.07.2 Adapting to a new situation by imitating

1.2.07.3 Ignoring inappropriate behaviors

2. LOCATING INFORMATION

2.1 Using a Library

- 2.1.01 Using alphabetical order
- 2.1.02 Knowing the library arrangement
- 2.1.03 Using the Reader's Guide
- 2.1.04 Using the card catalogue
- 2.1.05 Differentiating fictional from factual sources
- 2.1.06 Listing sources properly in reports
- 2.1.07 Identifying and using reference works
- 2.1.08 Identifying and using periodicals

2.2 Using state government bulletins and pamphlets

2.3 Using national government bulletins and pamphlets

2.4 Contacting local agencies

2.5 Contacting businesses

2.6 Determining appropriate sources of information for a given topic, problem, or question

2.7 Selecting and creating key words or phrases to guide search

3. PERCEIVING WRITTEN ORGANIZATION

3.1 Recognizing Patterns of General Writing

3.1.01 Identifying the chronological pattern

3.1.02 Identifying the spatial arrangement pattern

3.1.03 Identifying the cause and effect pattern

3.1.04 Identifying the comparison and contrast pattern

3.1.05 Identifying the opinion and supporting argument pattern

3.1.06 Identifying the question and answer pattern

3.1.07 Identifying the classification pattern

3.1.08 Identifying the conclusion and proof pattern

3.1.09 Identifying the problem and solution pattern

3.1.10 Identifying the deductive pattern

3.1.11 Identifying the inductive pattern

3.1.12 Identifying the analogy

3.2 Recognizing Patterns of Subject Area Writing

3.2.01 Identifying the sequence of events with dates pattern in social studies

3.2.02 Identifying the detailed statement of facts pattern in social studies

3.2.03 Identifying the propaganda pattern in social studies

3.2.04 Identifying the problem pattern in mathematics

3.2.05 Identifying the explanation pattern in mathematics

3.2.06 Identifying the number symbols pattern in mathematics

3.2.07 Identifying the geometric symbols pattern in mathematics

3.2.08 Identifying the explanation of a technical process pattern in science

3.2.09 Identifying the explanations for an experiment pattern in science

3.2.10 Identifying the detailed statement of facts pattern in science

3.2.11 Identifying the abbreviations and symbols patterns in science

3.2.12 Identifying the essay pattern in literature

3.2.13 Identifying the drama pattern in literature

3.2.14 Identifying the story pattern in literature

3.2.15 Identifying the biography pattern in literature

3.2.16 Identifying the fable pattern in literature

3.2.17 Identifying the poetry pattern in literature

4. READING WITH FLEXIBILITY

4.1 Skimming to Preview a Book

- 4.1.01 Looking over the title page
- 4.1.02 Reading chapter titles
- 4.1.03 Reading headings, subheadings and words in special type
- 4.1.04 Reading first and last paragraphs
- 4.1.05 Reading parts of paragraphs containing key sentences

4.2 Skimming for the Main Idea in Paragraphs

- 4.2.01 Rapid detection of the author's style of writing
- 4.2.02 Recognition of key words
- 4.2.03 Skipping words and sentences that lead up to the main idea

4.3 Scanning to Locate Specific Information

- 4.3.01 Locating an address, date, etc.
- 4.3.02 Finding a telephone number

4.4 Scanning to Answer a Question

4.5 Surveying Using SQ3R and SQ4R

- 4.5.01 Surveying - Glance over the headings to get the big points
- 4.5.02 Questioning - Turn the headings into questions
- 4.5.03 Reading - Read to answer the question, outline if necessary
- 4.5.04 Reciting - Recite the answer to the question without the book

4.5.05 Repeating - Repeat steps 2, 3, and 4 for each section

4.5.06 Reviewing - Go over material and notes to be sure you understand

4.6 Applying SQ3R to Problem Solving

4.6.01 Surveying - Decide the type of logic required and formula

4.6.02 Questioning - List the knowns and unknowns

4.6.03 Solving - Find the unknown factor

4.6.04 Checking - Substitute the answer original statement

4.6.05 Repeating - Apply the same steps to each successive problem

4.6.06 Reviewing - Check over the whole assigment again.

4.7 Adjusting Rate of Reading to Purpose for Reading

4.7.01 Reading to find a specific date

4.7.02 Reading to locate a telephone number

4.7.03 Reading directions

4.7.04 Reading in a familiar field

4.8 Adjusting Rate of Reading to Difficulty of Material

5. PRODUCING ORGANIZATION

5.1 Notetaking

5.1.01 Becoming familiar with the content from which notes will be taken

5.1.02 Labeling notes as to topic, time, and reference

5.1.03 Establishing a consistent format

5.1.04 Taking notes in the learners own words, rather than massive quotes

5.1.05 Developing personalized abbreviations and symbols

5.1.06 Listening for key ideas

5.1.07 Identifying cues which indicate key ideas

5.1.07.1 Checking course outline and/or objectives for the main ideas

5.1.07.2 Checking the blackboards, charts, maps, etc. for the main points

5.1.07.3 Listening to the opening statements for overview of the lecture

5.1.07.4 Listening for listings such as first, second, and third for a heirarchy of main points

5.1.07.5 Listening for indications of transitions such as pauses and changes in voice

5.1.07.6 Listening for the lecturers simple statements such as "remember this point," to indicate key ideas

5.1.07.7 Listening for summary statements or conclusions that review the essence of the lecture

5.1.08 Reviewing notes at the end of the lecture in order to organize and edit

5.2 Outlining

5.2.01 Scanning the materials to be outlined for organizational structure

5.2.02 Determining the pattern or organization used in the material

5.2.02.1 Chronological

5.2.02.2 Spatial arrangement or the telling of events according to their location

5.2.02.3 Cause and effect

5.2.02.4 Comparison and contrast

5.2.02.5 Question and answer

5.2.02.6 Analogy

5.2.02.7 Classification

5.2.02.8 Problem and solution

5.2.02.9 Other patterns common in subject areas

5.2.03 Recognizing the main ideas which develop the organizational pattern

5.2.04 Recognizing subordinate or supporting details as subtopics to be classified under main headings

5.2.05 Using standard form of outline, place the topics accordingly

5.2.06 Making the outline only as detailed as the purpose dictates

5.3 Summarizing

5.3.01 Choosing the best sentence to summarize a paragraph with an explicitly stated idea

5.3.02 Choosing the best sentence to summarize a longer selection with an explicitly stated idea

5.3.03 Stating an idea in a single sentence from a selection with an implicitly stated idea

5.3.04 Combining the author's ideas into shorter statements to summarize a paragraph

5.3.05 Answering broad organizational questions to summarize longer selections

5.3.06 Recognizing different types of paragraphs and their functions and making summary statements to this effect

6. LEARNING WITH OTHERS

6.1 Contributing to Groups

6.1.01 Contributing relevant ideas

6.1.02 Giving reasons for statements made

6.1.03 Defining terms used

6.1.04 Giving examples

6.1.05 Answering questions asked to the group

6.1.06 Taking interpersonal risk

- 6.1.01.1 Contributing personal experiences
- 6.1.01.2 Contributing impressions and feelings
- 6.1.01.3 Asking a question when a point is not clear
- 6.1.01.4 Brainstorming out loud
- 6.1.01.5 Disagreeing with a group member
- 6.1.01.6 Reinforcing the ideas of a group member
- 6.1.01.7 Stating an opinion
- 6.1.01.8 Reacting intellectually rather than emotionally

6.2 Listening in Groups

6.1.01 Paraphrasing to clarify a point

6.1.02 Attending closely to each speaker

6.1.03 Observing facial expressions for cues to meaning

6.1.04 Discriminating relevant from irrelevant contributions

6.1.05 Recognizing unsupported ideas

6.1.06 Recognizing emotionality

6.3 Perceiving a Role in a Group

6.3.01 Assuming leadership or followship as the situation demands

6.3.02 Identifying common goals with other learners

6.3.03 Accepting conflicting ideas

6.4 Discussing in Groups

6.4.01 Defining the purpose of the discussion group as

6.4.01.1 Settling an issue

6.4.01.2 Solving a problem

6.4.01.3 Making a judgment

6.4.01.4 Building an attitude

6.4.01.5 Sharing ideas

6.4.02 Organizing a discussion group

6.4.02.1 Electing a chairman, recorder, observer

6.4.02.2 Defining the rules of contributing

6.5 Brainstorming in Groups

6.5.01 Selecting a problem that needs a creative solution

6.5.02 Accepting no negative comments or judgments

6.5.03 Reinforcing bizarre ideas

6.5.04 Recording ideas

6.5.05 Grouping similar ideas

6.5.06 Evaluating ideas at a later time

6.6 Role Playing

6.6.01 Selecting the role playing problem

6.6.02 Using warm-up sessions

6.6.03 Explaining roles in the situation

6.6.04 Assigning of roles

6.6.05 Assigning audience participation

6.6.06 Explaining and interpreting the drama

6.6.07 Generalizing and applying to real-life situations

6.6.08 Sharing insights

6.6.09 Suggesting behavioral alternatives

6.6.10 Suggesting recasting of the drama

6.6.11 Validating the way the roles were played.

6.7 Tutoring

6.7.01 Identifying a tutor to help a learner

6.7.02 Identifying learners who can benefit from tutor's knowledge

6.7.03 Use positive reinforcement correctly

6.7.04 Showing or telling pupil correct response when he is incorrect

6.7.05 Eliciting the correct response by using questions before continuing

6.7.06 Repeating question using different words if learner does not understand

6.7.07 Avoiding attempts to elicit correct response by prompting

6.7.08 Avoiding negative verbal behavior when a learner fails to respond correctly

6.7.09 Present unfamiliar concepts in a variety of ways

6.7.10 Putting the learner at ease

6.7.11 Keeping a tutoring log

6.7.12 Making instructional prescriptions

6.7.13 Conducting small group discussions

6.7.14 Evaluating tutoring session

6.7.15 Asking question to tutor directly related to material

7. DEMONSTRATING LEARNING ON TESTS

7.1 Studying

7.1.01 Reviewing other skills

7.1.02 Studying quizzes and examinations given in previous years

7.1.03 Becoming familiar with the purpose and format of the test

7.2 Scheduling

7.2.01 Knowing time allotment for completion of the test

7.2.02 Reviewing the entire test before starting to answer any questions

7.2.03 Making a schedule for progress through the test

7.2.04 Working as rapidly as possible, ommitting or guessing at puzzling items

7.2.05 Concentrating on those items which will yield the most points in a given period of time

7.2.06 Using time remaining after completion of the test to reconsider and improve answers

7.3 Reading Directions and Questions Carefully

7.3.01 Becoming familiar with test directions ahead of time

7.3.02 Paying attention to those parts of the directions which most influence how the test will be taken

7.3.03 Keeping the directions in mind when answering the test items

7.3.04 Being alert to read the questions as they are

7.3.05 Paying attention to the key terms in the questions

7.3.06 Revieving interpretations of directions and questions at the end of the test

7.4 Using Good Reasoning Techniques

7.4.01 Attempting every question

7.4.02 Interacting with each question

7.4.03 Translating material in a question to different form

7.5 Interpreting Essay Questions

7.5.01 Using the general skills of test-taking

7.5.02 Jotting down beside each question the points which come to mind

7.5.03 Organizing the answer before writing

7.5.04 Writing to the point

7.5.05 Writing something for every essay question

7.5.06 Answering in outline form if time does not permit a complete answer

7.5.07 Writing legibly

7.6 Interpreting Sentence Completion Items

7.6.01 Guessing

7.6.02 Making the completed statement logically consistent

7.6.03 Making use of Grammar to help decide the correct answer

7.6.04 Considering the number and length of the blanks to be filled in

7.7 Interpreting Objective Test Items

7.7.01 Remembering the general principles of test-taking

7.7.02 Choosing the answer which the test maker intended

7.7.03 Anticipating the answer, then looking for it

7.7.04 Considering all alternatives

7.7.05 Relating options to the question

7.7.06 Balancing options against each other

7.7.07 Using information from other questions and options

7.7.08 Looking for specific determiners

7.7.09 Making statements true only if they are true without exception

7.7.10 Guessing if one or more answers can be eliminated

8. MEMORIZING

8.1 Employing Mnemonic Devices

8.1.01 Determining need for rote memorizing as opposed to other types of learning

8.1.02 Recognizing that practice alone has little effect on improving memory

8.1.03 Stating circumstances where an accurate memory is helpful

8.1.04 Knowing that all systems attempt to relate new material to preciously learned organizational scheme

8.1.05 Knowing that the extra store of embellished material presents no problem of capacity

8.1.06 Knowing that all systems aid memory by organizing the material to be learned

8.1.07 Knowing that the capacity for memorizing increases with the number of previously learned dimensions, images and details

8.1.08 Knowing that the key problem of memory is retrieval, not storage

8.1.09 Recognizing that individuals differ in which methods they employ most effectively

8.1.10 Gaining insight into own methods in order to improve their efficiency

8.1.11 Employing method of key words

8.1.11.1 Knowing purpose of method

8.1.11.2 Learning the key rhyme

8.1.11.3 Making associative images

8.1.11.4 Recalling words serially or in random access

8.1.12 Employing methods of rhymes or rhythms

8.1.13 Employing method of loci

8.1.13.1 Knowing purpose of method

8.1.13.2 Learning the details of a spacious and varied building

8.1.13.3 Associating items to be remembered with parts and furnishings of building by use of images

8.1.13.4 Retrieving by touring building mentally; making associations by means of images

8.1.13.5 Rehearsing the mental touring and associating

8.1.13.6 Knowing the desirable properties of images

8.1.13.7 Knowing the desirable properties of loci

8.1.14 Employing the method of analytic substitution

8.1.14.1 Knowing purpose and evaluation of method

8.1.14.2 Learning sets of consonant sound equivalents of digits

8.1.14.3 Translating digits to consonants

8.1.14.4 Supplying vowels to make words, phrases, sentences

8.2 Using the Short Term Store

8.2.01 Knowing purposes

8.2.02 Knowing the small capacity

8.2.03 Using short term store effectively

8.2.03.1 Translating visual images into words

8.2.03.2 Clarifying sounds of words to avoid confusion with similarly sounding words

8.2.03.3 Grouping items by categories

8.2.03.4 Grouping items by order

8.2.03.5 Grouping items by two's or three's within sets

8.2.03.6 Exposing items to self slowly

8.2.03.7 Repeating exposure of items

8.2.03.8 Rehearsing items without exposure to them

8.3 Using the Long Term Store

8.3.01 Knowing the purpose of the long term store

8.3.02 Knowing the large capacity

8.3.03 Chunking

8.3.03.1 Dealing with only about five units of information at a time

8.3.03.2 Chunking by similarity of sound

8.3.03.3 Chunking by similarity of meaning

8.3.03.4 Chunking by similarity of function

8.3.03.5 Chunking by relevance to personal experience

8.3.03.6 Clustering chunks into higher order groups by an organizing scheme

8.3.03.7 Forming a hierarchy of groups based on a meaningful principle

8.3.04 Sequencing items into a meaningful order

8.3.05 Clarifying the meanings of concepts and relationships

8.3.06 Interpreting in own words the meanings of material

8.3.07 Considering the source of the material

8.3.08 Considering the purpose of learning material

8.3.09 Considering the accuracy (or bias) of material

8.3.10 Determining the amount of detail needed in recall

8.3.11 Separating the facts from conclusions or impressions to avoid later inaccurate recall

8.3.12 Determining the type of organization present in the material (taxonomic, temporal, cause and effect, etc.)

8.3.13 Relating new material to what one already knows

8.3.14 Imagining the future benefits of remembering the matieral

9. ATTAINING CONCEPTS

9.1 Categorizing Objects or Events

9.1.01 Classifying on one attribute

9.1.02 Classifying on conjunction of attributes

9.1.03 Classifying on disjunction of attributes

9.1.04 Classifying on relations between attributes

9.2 Describing a Class Verbally

9.2.01 Naming members of a class

9.2.02 Stating synonyms

9.2.03 Naming subordinate classes

9.2.04 Naming superordinate classes

9.2.05 Using the concept in a sentence

9.3 Defining a Class Formally

9.3.01 Stating relevant attributes

9.3.02 Stating rules of combining attributes

9.4 Ordering Objects or Events

9.4.01 Ordering along one dimension

9.4.02 Ordering multi-dimensionally

9.4.03 Defining the relevant dimensions verbally

9.5 Determining Meaning

9.5.01 Determining meaning from context

9.5.02 Determining meaning from synonyms

9.5.03 Determining meaning from explanations

9.5.04 Selecting appropriate meaning from several dictionary definitions

9.5.05 Recognizing words one uses without full understanding

9.5.06 Enriching meaning of concepts already known

9.5.07 Reviewing information locating skills

9.6 Defining a concept requiring verbal labels

9.6.01 Recognizing subordinate concepts

9.6.02 Arranging subordinate concepts in a hierarchy

9.6.03 Listing subordinate concepts

10. PROBLEM SOLVING

10.1 Determining the Problem Characteristics

10.1.01 Evaluating the adequacy of problem presentation

10.1.02 Determining the need to find a problem

10.1.03 Reformulating the problem

10.1.04 Determining if a standard solution is applicable

10.1.05 Selecting an appropriate resource person

10.1.06 Determining if a solution is known by others

10.1.07 Asking appropriate questions to a resource person

10.1.08 Determining if a novel solution should be attempted

10.1.09 Determining the required memory load

10.1.10 Establishing the criteria for a solution

10.1.11 Searching the environment for cues

10.1.12 Determining if convergent activity is required

10.1.13 Determining if divergent activity is required

10.1.14 Determining if the outcome is to be a principle

10.1.15 Determining if the outcome is to be a procedure

10.1.16 Recording required information

10.1.17 Restating the problem

10.1.18 Learning needed concepts

10.1.19 Developing the prerequisite skills

10.1.20 Learning the needed principles

10.2 Establishing a Problem Solving Set

10.2.01 Considering personal motives

10.2.02 Seeking clear directions from others

10.2.03 Seeking written instructions

10.2.04 Being alert for unintentional cues from others

10.2.05 Drawing upon previous learning

10.2.06 Seeking examples provided by others

10.2.07 Refining the solution goals

10.3 Maintaining Flexibility of Set

10.3.01 Focusing alternately on parts and whole

10.3.02 Considering the functions of objects other than the obvious

10.3.03 Classifying the objects by attributes

10.3.04 Classifying the objects by functions

10.3.05 Labeling objects verbally to facilitate applications

10.3.06 Redefining the problem characteristics periodically

10.3.07 Restating the problem in different terms

10.3.08 Manipulating the objects, concepts, symbols freely

10.3.09 Transforming from one mode to another (verbal, spatial, graphic, etc.)

10.3.10 Viewing the problem from perspectives of persons in different roles

10.4 Seeking Information

10.4.01 Estimating the amount of work required by each avenue of attacking problem

10.4.02 Estimating the probability of success for each avenue of attack

10.4.03 Determining the optimal strategy based upon estimates of work and success

10.4.04 Using the half-split strategy

10.4.05 Seeking constraints

10.4.06 Collecting data

10.4.07 Evaluating data

10.4.08 Questioning more knowledgeable persons

10.4.09 Observing more advanced persons

10.4.10 Referencing written sources

10.5 Using Symbols

10.5.01 Counting

10.5.02 Labeling the individual pieces of data

10.5.03 Labeling the classes

10.5.04 Assigning mathematical symbols

10.5.05 Rearranging the symbols

10.5.06 Symbolizing the solution as a target

10.5.07 Representing constraints

10.5.08 Translating solutions from symbols to real world

10.6 Making and Testing Hypotheses

10.6.01 Re-examining the problem characteristics

10.6.02 Stopping to think

10.6.03 Thinking about what is being done while it is being done

10.6.04 Varying each factor in succession

10.6.05 Keeping records of hypotheses and results

10.6.06 Anticipating possible consequences

10.6.07 Generating alternative hypotheses

10.6.08 Deriving principles

10.6.09 Stating principles explicitly

10.6.10 Testing hypotheses covertly

10.6.11 Testing hypotheses symbolically

10.6.12 Testing hypotheses overtly

10.6.13 Evaluating a solution

10.6.14 Estimating the likelyhood of a solution more efficient than one already obtained

10.6.15 Determining if a better solution is needed

10.6.16 Determining if a solution can be generalized

11. REASONING

11.1 Reasoning Deductively

11.1.01 Recognizing universal affirmative propositions

11.1.02 Recognizing universal negative propositions

11.1.03 Recognizing particular affirmative propositions

11.1.04 Recognizing particular negative propositions

11.1.05 Recognizing implications

11.1.06 Translating propositions and implications into symbolic form

11.1.07 Rearranging ordinary sentences into logical proposition form

11.1.08 Stating the inverse of an implication

11.1.09 Stating the converse of an implication

11.1.10 Stating the contrapositive of an implication

11.1.11 Stating the truth value of an inverse, converse, or contrapositive

11.1.12 Applying the law of transitivity to an order relation

11.1.13 Stating the negation of a statement

11.1.14 Stating the truth value of a three-line syllogism having true or plausible premises

11.1.15 Stating the truth value of a three-line syllogism with false, meaningless, or unacceptable premises

11.1.16 Supplying a conclusion for two plausible premises

11.1.17 Supplying a conclusion for two implausible premises

11.1.18 Detecting the error of the excluded middle term

11.1.19 Detecting the error of basing a conclusion on two particular premises

11.1.20 Making positive statements by eliminating other alternatives

11.1.21 Determining truth value of compound propositions by use of truth tables

11.1.22 Using Euler Circles

11.1.23 Using Venn Diagrams

11.1.24 Recognizing a deductive argument in prose

11.1.25 Evaluating a deductive argument in prose

11.2 Reasoning Inductively

11.2.01 Classifying

11.2.02 Ordering

11.2.03 Seeking common characteristics

11.2.04 Varying one factor at a time

11.2.05 Making hypotheses

11.2.06 Testing hypotheses on additional similar cases

11.2.07 Testing hypotheses on cases with varying characteristics

11.2.08 Testing hypotheses by looking for counterexamples

11.2.09 Reviewing principles of Attaining Concepts

11.2.10 Reviewing principles of Problem Solving

11.2.11 Recognizing probabilistic nature of deductive conclusions

11.2.12 Recognizing an inductive argument in prose

11.2.13 Evaluating a deductive argument in prose

11.3 Reasoning by Analogy using the relationships:

11.3.01 Means the same as

11.3.02 Means the opposite of

11.3.03 Is a type of

11.3.04 Is an adjective describing

11.3.05 Usually becomes

11.3.06 Comes before (after)

11.3.07 Is a cause of

11.3.08 Is an effect of

11.3.09 Usually goes with

11.3.10 Is used for

11.3.11 Is done by

11.3.12 Is used by

11.3.13 Is made of

11.3.14 Is a larger (smaller) version of

11.3.15 Is more (less) than

11.3.16 Is a measure of

11.3.17 Has the purpose of

11.3.18 Is located in (by, around)

12. PRODUCTIVE THINKING

12.1 Preparing for Production

12.1.01 Expecting long or irregular intervals between creative products

12.1.02 Assigning lower priorities to competing activities

12.1.03 Exposing self to wide range of stimulating activities in daily life

12.1.04 Maintaining interests of either masculine or feminine character

12.1.05 Maintaining efforts to gain a good general education

12.1.06 Beginning creative efforts as soon as a need arises

12.1.07 Finding problems needing a creative solution

12.2 Producing

12.2.01 Improving on existing solutions or creations

12.2.02 Elaborating on new ideas at great length

12.2.03 Recording ideas any time they occur

12.2.04 Maintaining critical attitude to conventional wisdom

12.2.05 Tolerating negative criticism

12.2.06 Sacrificing some social activities or amusements

12.2.07 Asking stimulating questions of oneself and others

12.2.08 Making unusual responses

12.2.09 Emphasizing activity and quantity while producing

12.2.10 Alternating direct efforts with incubation efforts

12.2.11 Maintaining own independence of thought and action

12.2.12 Remaining open to own feelings and emotions

12.3 Evaluating the Product

12.3.01 Seeking specialized knowledge to improve judgemental skills

12.3.02 Emphasizing quality when selecting from own products

12.3.03 Examining previous attempts of others

12.3.04 Emphasizing merits of others' work rather than faults

SAMPLE OBJECTIVES AND ITEMS

1.	Self managing
1.1	Setting performance goals
1.1.01	Analyzing a task
1.1.01.01	Analyzing a familiar task
1.1.01.01.01	Selecting appropriate steps from a list

Objective:

Given a task which is familiar to the learner, involving from five to eight behaviors, and a list of behaviors, the learner will check behaviors which are necessary to perform the task.

Item:

Johnny's teacher assigns him the task of finding some book on the history of wheat farming in the United States. Check the steps that are necessary to do the task using a library.

__X__ A. Use the card catalogue

__X__ B. Know library arrangement

__X__ C. Determine the key words to use the subject index

____ D. Locate wheat farms in an atlas

__X__ E. Locate the book on the shelf

____ F. Wash hands before handling the book

____ G. Determine the author's birth date from the card catalogue

____ H. Determine the name of the publisher from the card catalogue

1.	Self managing
1.1	Setting performance goals
1.1.01	Analyzing a task
1.1.01.02	Analyzing an unfamiliar task
1.1.01.02.01	Selecting appropriate steps from a list

Objective:

Given a task which is unfamiliar to the learner, involving from five to eight behaviors, the learner will check behaviors which are necessary to perform the task.

Item (a):

Imagine that your task is to draw a mural depicting pioneers crossing the Rocky Mountains. Mark the steps necessary for completing the task.

____ 1. Collect pictures of mountains in New York.

_X_ 2. Sketch the mural you want to draw.

____ 3. Draw Denver in the background.

____ 4. Put the people on the left and the mountains on the right.

_X_ 5. Collect paper, paints, etc.

____ 6. Draw a big bright sun in the upper corner.

_X_ 7. Balance the picture with people, horses, wagons, etc.

_X_ 8. Use both bright and dull colors.

_X_ 9. Fill up all the space on the paper.

____ 10. Make sure the covered wagons stand out.

Item (b):

Imagine that you live in Pittsburg and wish to compute the local time in San Francisco where your friend lives. Mark with an X those items necessary to solve the problem.

_____ 1. Your friend's home is on Lake Street.

__X__ 2. Pittsburg is in the Eastern time zone.

__X__ 3. San Francisco is in the Pacific time zone.

_____ 4. Denver is two-thirds the distance from Pittsburg to San Francisco.

__X__ 5. Two time zones separate the Eastern and Pacific time zones.

__X__ 6. There is one hour's difference between adjacent zones.

_____ 7. You live on 37th Avenue.

_____ 8. San Francisco is 1850 miles from Pittsburg.

__X__ 9. It is 9 o'clock in Pittsburg.

1.	Self managing
1.1	Setting performance goals
1.1.01	Analyzing a task
1.1.01.02	Analyzing an unfamiliar task
1.1.01.02.02	Ordering the given needed steps

Objective:

Given an unfamiliar task of five to eight steps requiring sequential performance, the learner will number the steps in the appropriate order.

Item:

Imagine that your task is to design a one-page newspaper. Given are variously sized newspaper clippings and a piece of construction paper. Number the following steps in the order they should be performed.

__3__ a. Make the spaces between clippings 1/4 inch.

__4__ b. Sketch a clipping arrangement to be used.

__1__ c. Collect paper, paste, pencil and ruler.

__5__ d. Paste the clippings according to your design.

__2__ e. Make the side and top margins 1 inch, the bottom margin 1 1/2 inches.

3. Perceiving written organization
3.1 Recognizing patterns of general writing
3.1.04 Identifying the comparison and contrast pattern

Objective:

Given a reading selection using the comparison and contrast pattern of writing and given four choices of writing patterns, the learner will underline the writing pattern used in the selection.

Item:

Underline the writing pattern used in the following selection.

A glossary and a dictionary are very much alike. However, they also differ in certain ways. While a dictionary is usually a book by itself, a glossary is a few pages contained within a book, usually at the end. Although both a dictionary and a glossary help you to pronouce and know the meanings of words, there is a considerable difference in their comprehensiveness. A dictionary lists the pronunciation and meanings of thousands of words, while a glossary helps you pronounce and know the meanings of a certain few words which can be found in the book of which the glossary is a part.

A. Chronological pattern

B. Cause and effect pattern

C. Comparison and contrast pattern

D. Classification pattern

4. Reading with flexibility
4.7 Adjusting rate of reading to purpose for reading

Objective:

Given three purposes for reading and three reading rates from which to choose, the learner will write the number of the appropriate reading rate beside each purpose.

Item:

Write the number of the appropriate reading rate beside each purpose listed below:

Reading a novel for leisure 1
Reading directions 3
Reading headings, subheadings, and words in special type 2

1. Average reading rate
2. Scanning or skimming
3. Slowly in detail

5. Producing organization
5.2 Outlining
5.2.04 Recognizing subordinate or supporting details as subtopics to be classfied under main headings.

Objective:

Given a reading selection and an outline of the selection with main headings supplied, and a list of supporting details, the learner will write the number of the supporting details in their appropriate place in the outline.

Item:

Read the following paragraph:

The history of kite making is a long one. Kites were used as long as 2000 years ago. The inventor, however, is not known. Kites have varied uses. Among these are as toys to amuse people, to drive out evil spirits, as signals when sending messages, and weather forecasting. Several kinds of kites are commonly used. These include flat ones of many varied shapes, box types, and elaborately ornamented Chinese kites.

Write the number of the supporting details in their appropriate place in the outline.

I. History of kite making

A. 2
B. 7

II. Use of kites

A. 4
B. 1
C. 8

III. Kinds of kites

A. 3
B. 5
C. 6

1. To drive out evil spirits
2. Found in China 2000 years ago
3. Flat
4. As toys to amuse
5. Box
6. Elaborately ornamented
7. Actual inventor not known
8. As signals

6.1 Contributing in groups
6.1.01 Contributing relevant ideas

Objective:

Given a dialogue of a group discussion with relevant and irrelevant ideas numbered, the learner will write the number(s) of the irrelevant ideas.

Item:

Underline the irrelevant ideas in the discussion below:

1. Teacher: "This discussion is for the purpose of deciding what kind of committees the senior class needs next year."

2. Pete: "I think I should be head of the social committee."

3. Jennifer: "We do need a social committee to take care of the two dinners and the three dances that are scheduled."

4. Mark: "What committees did we have this year?"

5. Ken: "We had two--the social committee and the president's committee."

6. Ken: "I though the president's committee did a good job of running the election."

7. Jennifer: "I think we should have a party."

9. Attaining concepts
9.1 Categorizing objects or events
9.1.6 Classifying on conjunction of events

Objective:

Given three descriptive attributes and a list of five familiar objects or events, the learner will underline the objects or events which simultaneously possess the three attributes.

Item:

Underline the one word below which describes a passenger-carrying, land vehicle.

A. Tractor

B. Locomotive

C. Automobile

D. Airplane

E. Engine

10. Problem solving
10.4 Seeking information
10.4.07 Evaluating data

Objective:

Given a problem situation and five proposed solutions, the learner will underline the proposed solution that contains the one item of information need to resolve the situation.

Item:

A motorist in a strange town asks a friendly service station attendant for directions to the city hall. The attendant replies, "Go on the way you're headed, turn at the second traffic light, and the city hall will then be four blocks ahead, on your right." Underline the response the motorist should make.

A. Thank the attendant for the complete, clear directions

B. Ask which way to turn at the traffic light

C. Ask how far it is to the traffic light

D. Ask for a description of the city hall

E. Ask for the name of the street the city hall is on

10. Problem solving
10.4 Seeking information
10.4.07 Evaluating data

Objective:

Given a story problem and a list of five facts, one of them irrelevant, the learner will underline the irrelevant fact.

Item:

A family make an auto trip. After returning, the father wanted to figure the average cost per day per person. He also wanted to know the miles per gallon of gasoline used.

Underline the fact that is not needed.

A. They spent $400.

B. The trip lasted five days.

C. They crossed six states.

D. They traveled 1500 miles.

E. They used 95 gallons of gasoline.

SELECTED INSTRUCTIONAL MATERIALS FOR LEARNING SKILLS

1. ACADEMIC PRESCHOOL, THE (BEREITER-ENGELMANN LANGUAGE TRAINING PROJECT)

   Bereiter, C. and S. Engelmann. Teaching Disadvantaged Children in the Preschool. Englewood Cliffs, N.J.: Prentice-Hall, 1966.

2. ADVENTURES IN DISCOVERY

   Holl, A. Teacher's Guide to Adventures in Discovery. New York: Western Publishing Company, 1970.

3. AMELIORATIVE CURRICULUM, THE

   Karnes, M. M., et.al. The Ameliorative Curriculum: Guilford Activities. Champaign-Urbana, Ill.: University of Illinois, 1970.

4. BE A BETTER READER

   Smith, Nila B. Be a Better Reader. Englewood Cliffs, N.J.: Prentice-Hall, 1964.

5. CHILD (Coordinated Helps In Language Development)

   Northam. S. B. (ed.). CHILD (Coordinated Helps in Language Development-Language Lessons for Kindergarten). Portland, Ore.: Northwest Regional Educational Laboratory, 1970.

6. CHILDREN'S THINKING-HEATHCOTE SCHOOL

   Heathcote School. Children's Thinking. Scarsdale, N.Y.: Scarsdale Public Schools, 1963.

7. CONCEPTS AND INQUIRY

   Educational Research Council of America. Concepts and Inquiry. Boston: Allyn and Bacon, 1970.

8. CONCEPTUAL SKILLS PROGRAM

   Ontario Institute for Studies in Education. Conceptual Skills Program. Toronto, Canada: Ontario Institute for Studies in Education, 1967.

9. COPING CURRICULUM, THE

   Macomber, L. P. The Coping Curriculum-Learning to Learn Curriculum. Unpublished materials, Temple University, Philadelpha, n.d.

10. CREATIVE THINKING KITS: A PROGRAM FOR MIDDLE GRADES

    Youngs, R. C. and S. L. Youngs, Creative Thinking Kits: A Program for Middle Grades. Normal, Ill.: Youngs and Youngs, 1970.

11. DECISION MAKING

Dodder, C. and B. Dodder. Decision Making. Boston: Beacon Press, 1968.

12. DEVELOPING CONGITIVE SKILLS IN YOUN LEARNERS

Classroom Materials Company. Developing Cognitive Skills in Young Learners, Great Neck, N.Y.: Classroom Materials Company, 1967.

13. DIRECT TEACHING OF CRITICAL THINKING IN GRADES FOUR THROUGH SIX

Mason, J. M. "The Direct Teaching of Critical Thinking in Grades Four Through Six," Journal of Research in Science Teaching, 1:319-328, 1963.

14. EARLY CHILDHOOD DISCOVERY MATERIALS

Bank Street College of Education. Early Childhood Discovery Materials. New York: Macmillan Company, 1969.

15. EARLY LEARNING CURRICULUM, AN

Resnick, L. B. Design of an Early Learning Curriculum. Pittsburgh: Learning Research and Development Center, University of Pittsburgh, 1967.

16. ELEMENTARY SCIENCE STUDY

Education Development Center. Elementary Science Study. Manchester, Mo.: Webster Division, McGraw-Hill Company, 1966.

17. EFFECTIVE READING AND LEARNING

Shaw, Phillip B. Effective Reading and Learning. New York: Thomas V. Crowell Company, 1958.

18. EFFICIENT STUDY SKILLS

Downes, Mildred G. Efficient Study Skills. Cambridge: Educators Publishing Service, 1963.

19. EXAMPLARY UNIT ON INFERENCE EVALUATION, AN

Saadeh, I. "The Teacher and the Development of Critical Thinking, " Journal of Research and Development in Education, 3:87-99, 1969.

20. FAMILY LIVING SERIES: ABOUT YOU

Cosgrove, M.C. and M.I. Josey. About You-Family Living Series. Chicago: Science Research Associates, 1952.

21. FIVE-DAY COURSE IN THINKING, THE

de Bono, E. The Five-Day Course in Thinking. New York: Basic Books, 1967.

22. FROSTIG PROGRAM FOR THE DEVELOPMENT OF VISUAL PERCEPTION, THE

Frostig, M. Frostig Program for the Development of Visual Perception. Chicago: Gollett, 1964.

23. HUMAN DEVELOPMENT LAB

Pennsylvania Advancement School. Human Development Lab. Philadelphia: Pennsylvania Advancement School, 1969.

24. IDEABOOKS

Myers, R. E. and E. P. Torrance. Can You Imagine? Boston: Ginn and Company, 1963.

Myers, R. E. and E. P. Torrance. For Those Who Wonder. Boston: Ginn and Company, 1966.

Myers, R. E. and E. P. Torrance. Invitations to Speaking and Writing Creatively. Boston: Ginn and Company, 1962.

Myers, R. E. and E. P. Torrance. Invititions to Thinking and Doing. Ginn and Company, 1961.

Myers, R. E. and E. P. Torrance. Plots, Puzzles, and Plays. Boston: Ginn and Company, 1966.

Myers, R. E. and E. P. Torrance. Stretch. Minneapolis: Perceptive, 1968.

25. IMAGI/CRAFT SERIES

Cunnington, B. F. and E. P. Torrance. Imagi/Craft Series. Boston: Ginn and Company, 1965.

26. IMPROVEMENT OF PROBLEM SOLVING PROCESSES

Johnson, D. M. Improvement of Problem Solving Processes. East Lansing, Mich.: Michigan State University, 1968.

27. INQUIRY DEVELOPMENT PROGRAM

Suchman, J. R. The Elementary School Training Program in Scientific Inquiry. Champaign-Urbana, Ill.: University of Illinois, 1962.

28. INQUIRY, DISCOVERY AND INVENTION

Merrick, P. D. Inquiry, Discovery and Invention. San Leandro, Calif.: Educational Science Consultants, 1969.

29. INQUISITIVE GAMES: EXPLORING NUMBER AND SPACE

Sprigle, H. A. Inquisitive Games: Exploring Number and Space. Chicago: Science Research Associates, 1968.

30. LEARNING READINESS SYSTEM

Scott, R., et.al. Learning Readiness System-Classification and Seriation Kit. Evanston, Ill.: Harper and Row, 1968.

31. LEARNING TO LEARN

Smith D. E. P. Learning to Learn. New York: Harcourt, Brace and and World, 1961.

32. LEARNING TO THINK SERIES

Thurstone, T. G. Learning to Think Series. Chicago: Science Research Associates, 1967.

33. LET'S LOOK AT CHILDREN

Let's Look at Children. Princeton, N. J.: Educational Testing Service, 1965.

34. MAN: A COURSE OF STUDY

Education Development Center. Man: A Course of Study. Cambridge, Mass.: Education Development Center, 1968.

35. MAN AND COMMUNITIES PROGRAM

Fideler, R. E., et.al.(eds.) Man and Communities. Grand Rapids, Mich.: Fidler Company, 1970.

36. MAN THE MEANING MAKER

Latourette, J. R. Man the Meaning Maker. Boston: Beacon Press, 1969.

37. MILWAUKEE SPEECH AND LANGUAGE PROGRAM

Milwaukee Public Schools. Program for Developing Speech and Language Skills in the Educationally Deprived Child Through the Utilization of the Specialized Training of Speech Therapists. Milwaukee: Milwaukee Public Schools, Division of Curriculum and Instruction, 1968.

38. MINNEMAST PROJECT

Werntz, J. Minnesota Mathematics and Science Teaching Project (MINNEMAST). Minneapolis: University of Minnesota, 1970.

39. NATIONAL SCHOOLS PROJECT

Williams, F. E. Classroom Ideas for Encouraging Thinking and Feeling. Buffalo, N.Y.: D.O.K. Publishers, 1970.

40. OPEN COURT KINDERGARTEN PROGRAM

Bereiter, C., A. Hughes, and V. Anderson. The Open Court Kindergarten Program. LaSalle, Ill.: Open Court Publishing Company, 1970.

41. PEABODY LANGUAGE DEVELOPMENT KITS

Dunn, L. M., J. O. Smith, and K. B. Horton. Peabody Language Development Kits. Circle Pines, Minn.: American Guidance Service, 1965.

42. PERRY PRESCHOOL PROJECT

Weikart, D. P., et.al. Longitudinal Results of the Ypsilanti Perry Preschool Project. Ypsilanti, Mich.: High/Scope Educational Research Foundation, 1970.

Weikert, D. P. (ed.). Preschool Intervention: Preliminary Report of the Perry Preschool Project. An Arbor, Mich.: Campus Publisher, 1967.

43. PLANNING FOR CHANGE

Center for Urban Education. Planning for Change: A Course in Urban Politics and Neighborhood Planning for the Fourth and Fifth Grades in New York City's Public Schools. New York: C. Richard Hatch Associates, 1968.

44. PROBLEM SOLVING IN MATHEMATICS

Robinson, F. G. and G. T. Evans. Problem Solving in Mathematics: Understanding Problems. Toronto, Canada: Ontario Institute for Studies in Education, 1971.

45. PROBLEM SOLVING IN SOCIAL STUDIES: A MODEL LESSON

Oklahoma City Public Schools. Problem Solving in Social Studies: A Model Lesson. Oklahoma City: Oklahoma City Public Schools, 1969.

46. PROCESS/CONCEPT SCIENCE

Aikman, J. (ed.). Process/Concept Science Series. Westchester, Ill.: Benefic Press, 1970.

47. PRODUCTIVE THINKING PROGRAM

Covington, M. V., R. S. Crutchfield, and L. B. Davies. The Productive Thinking Program. Berkeley, Califor.: Braselton Printing Company, 1966.

48. READING-THINKING SKILLS

Maney, E. S. Reading-Thinking Skills. Elizabethtown, Pa.: Continental Press, 1968.

49. SCHOLASTIC STUDY SKILLS BOOKS

Beech, L. Ask and Answer. New York: Scholastic Magazines and Book Services, 1968.

Beech, L. Reading Without Words. New York: Scholastic Magazines and Book Services, 1968.

Beech, L. Study Time Streamlined. New York: Scholastic Magazines and Book Services, 1968.

Scholastic Magazines. Map Skills Project Book II. New York: Scholastic Book Servic-s, 1964.

Hunt, L. Map Skills Project Book III. New York: Scholastic Book Services, 1965.

50. SCIENCE-A PROCESS APPROACH

American Association for the Advance of Science. Science-A Process Approach. New York: Zerox Corporation, 1968.

51. SCIENCE CURRICULUM IMPROVEMENT STUDY (SCIS)

Karplus, R. and H. D. Thier. Science Curriculum Improvement Study. Chicago: Rand McNally, 1969.

52. SENSE AND TELL

Marshall, J. S., I. Podendorf, and C. Schwartz. Sense and Tell. Glenview, Ill.: Scott-Foresman and Company, 1968.

53. SOCIAL SCIENCE LABORATORY UNITS

Lippitt, R., R. Fox, and L. Schaible. Social Science Laboratory Units. Chicago: Science Research Associates, 1969.

54. SRA BASIC SKILLS SERIES

Naslund, R. A. and R. E. Servey. Organizing and Reporting Skills: OR II. Chicago: Science Research Associates, 1962.

55. SRA BASIC SKILLS SERIES

Bracken, D. K., J. D. Hays, and C. J. Bridges. Listening Skills Program: Intermediate Level 11b. Tulsa, Ok.: International Teaching Tapes, 1968.

56. STUDY EXERCISES FOR DEVELOPING READING SKILLS

Neal, E. A. and I. Foster. Study Exercises for Developing Reading Skills. River Forrest, Ill.: Laidlow Brother, 1963.

57. STUDY MANUAL

Wittenberg, L. A Study Manual. New York: Grossett and Dunlap, 1969.

58. STUDY TYPE OF READING EXERCISES FOR SECONDARY SCHOOL

Strang, R. Study Type of Reading Exercises for Secondary School. New York: Columbia University, 1956.

59. SYNECTICS EDUCATION SYSTEMS

Synectics, Inc. Making It Strange 1, 2, 3, 4. New York: Harper and Row, 1967.

Synectics Education Systems. The Art of the Possible. Cambridge, Mass.: Synectics Education Systems, 1969.

Synectics Education Systems. Making it Whole. Cambridge, Mass.: Synectics Education Systems, 1969.

Synectics Education Systems. Facts and Guesses. Cambridge, Mass.: Synectics Education Systems, 1969.

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